

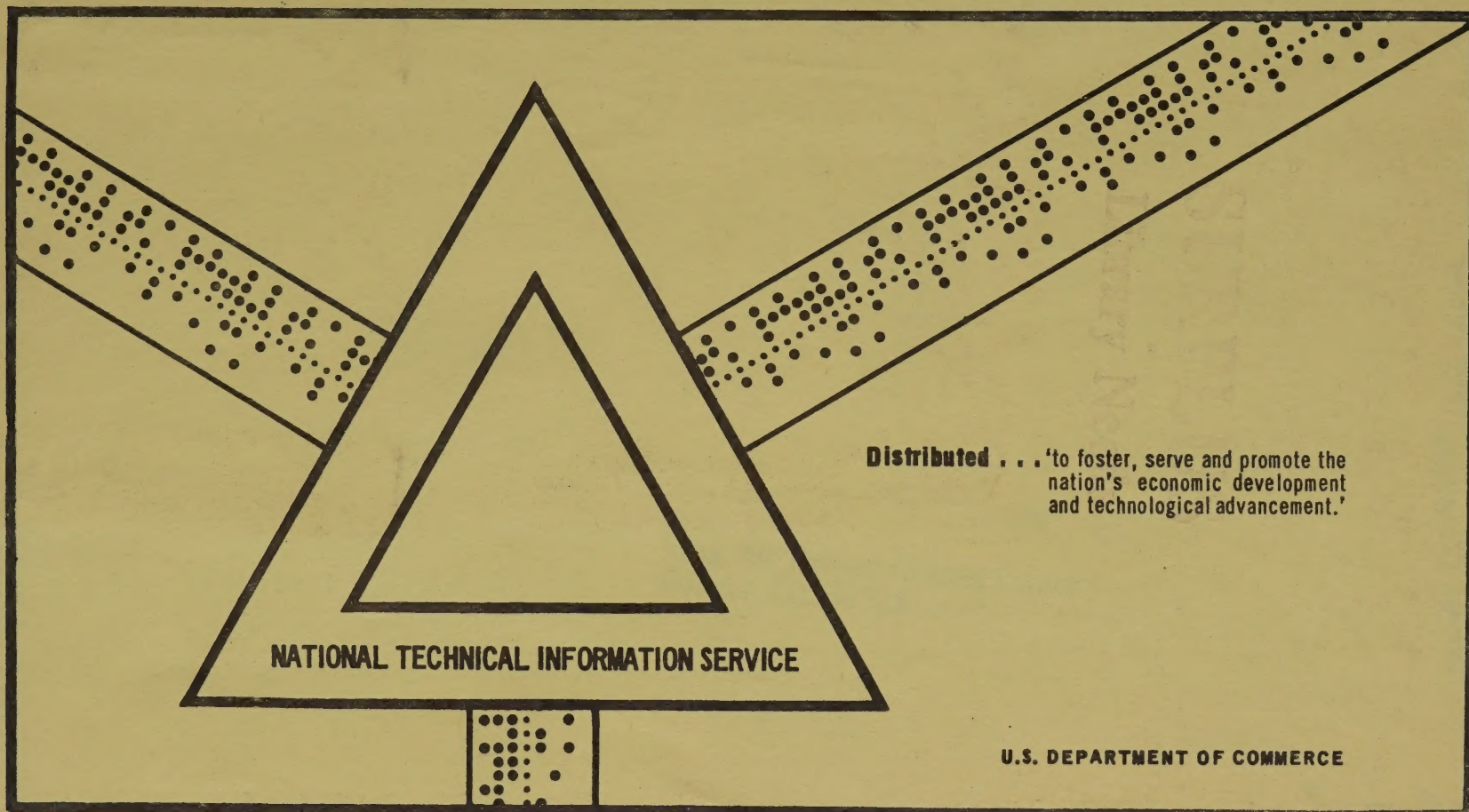
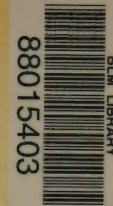
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FUTURE DEMANDS ON THE PUBLIC LANDS. VOLUME III: PROBABLE  
FUTURE DEMANDS ON PUBLIC LANDS

Robert S. Manthy

Public Land Law Review Commission  
Washington, D. C.

October 1970





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FUTURE DEMANDS ON THE PUBLIC LANDS

Volume III

Probable Future Demands on Public Lands

A Study Prepared  
for the  
Public Land Law Review Commission

Robert S. Manthy  
East Lansing, Michigan

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October 1970

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Public Land Law Review Commission

FUTURE DEMANDS ON THE PUBLIC LANDS. Volume III:

Probable Future Demands on Public Lands

by Robert S. Manthy

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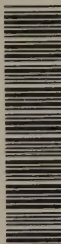
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note: This volume is the third in a four-part study of Future Demands on the Public Lands, prepared by the Commission staff with the assistance of four contractors and two consultants. The other three parts, published in three separate volumes, are subtitled as follows: Vol. I, Policy Impacts of Future Demands; Vol. II, Projections of the Consumption of Commodities Producible on the Public Lands of the United States 1980-2000; and Vol. IV, Probable Future Demands on the Public Lands for New Cities and Urban Expansion.

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# CONTENTS

	No. of Pages
SUMMARY . . . . .	S-1
CHAPTER	
I. INTRODUCTION . . . . .	1
II. AGRICULTURE AND FORAGE . . . . .	7
III. FISH AND WILDLIFE RESOURCES . . . . .	40
IV. OUTDOOR RECREATION . . . . .	61
V. TIMBER . . . . .	81
VI. WATER . . . . .	116
VII. ENERGY FUEL MINERALS . . . . .	137
VIII. SELECTED NONFUEL MINERALS . . . . .	168
IX. ANALYSIS OF POLICY IMPLICATIONS OF FUTURE DEMANDS . . . . .	191

## SUMMARY

The Public Land Law Review Commission, established by the Act of September 19, 1964<sup>1/</sup>, has the statutory responsibility to (1) "study existing statutes and regulations governing the retention, management, and disposition of the public lands"; (2) "review the policies and practices of the Federal agencies charged with administrative jurisdiction over such lands insofar as such policies and practices relate to the retention, management and disposition of these lands"; and (3) "compile data necessary to understand and determine the various demands on the public lands which now exist and which are likely to exist in the foreseeable future."

The future potential use of the public lands is a central focus of the entire study program. This is one of a series of studies designed to provide a basis for carrying out the statutory directive that the Commission recommend to the President and the Congress "such modifications in existing laws, regulations, policies, and practices as will, in the judgement of the Commission, best serve to carry out the policy" that "the public lands of the United States shall be (a) retained and managed or (b) disposed of, all in a manner to provide the maximum benefit for the general public."

This study draws upon the specific subject matter developed elsewhere in the PLLRC study program. It attempts to draw these materials together and to provide a broad analysis of the historical use of the public lands, the likely future trends in the potential production from them and the possible effects of alternative government policies affecting levels of output or use of these lands for supplying those commodities producible on the public lands.

The study report on "Projections of the Consumption of Commodities Producible on the Public Lands of the United States," prepared for the PLLRC by Robert R. Nathan Associates, Inc., is used where possible as a source of estimates

<sup>1/</sup>Pub. L. No. 88-606, 78 Stat. 982, Amended Pub. L. 90-213, 81 Stat. 660, 43 U.S.C. §§ 1391-1400 (1968 Suppl.)



of future national demands. The individual commodity studies prepared for the Commission and other published and unpublished reports provide the source of information about the relationships between national demand and the role of the public lands as a source of supply.

#### Scope

##### Commodities and Uses

The commodities and uses considered are: (1) agricultural crops and forage; (2) game and sport fish; (3) outdoor recreation; (4) timber; (5) water; (6) energy fuel minerals; and (7) nonfuel minerals. Another category of uses--public land occupancy uses for rights-of-way, governmental uses, residential, municipal and other uses of the spatial values of public lands--is not discussed. The PLLRC study of use and occupancy of Federal lands was not available when this report was prepared.

##### Federal Lands

The public lands of concern are lands defined by Section 10 of Public Law 88-606 and other Federal lands which have characteristics similar to, or are managed in conjunction with Section 10 land. Section 10 lands are defined as: (1) the public domain; (2) reservations created from the public domain (except Indian reservations); (3) withdrawn or reserved lands; (4) outstanding interests of the United States in lands patented, conveyed in fee or otherwise, under the public land laws; (5) national forests; (6) wildlife refuges and ranges; and (7) the submerged lands of the outer continental shelf.

##### Projections of Future Consumption Requirements

The purpose of reviewing projections of national demands or consumption requirements for the commodities discussed in this report is to determine the direction and the magnitude of future trends in the relative importance of the public lands as a source of commodity supply. In some instances, the measures of relative change are derived from highly quantified projections of individual commodities. In others, qualitative assessments of the implications of past trends is the only information available for projecting future trends.

The demand projections reviewed are not the only projections available; and they may not be what some analysts consider as the best projections available. However, the projections provided serve the purpose of indicating future trends. Other available projections generally do not differ radically enough from those used to indicate that the derived broad relative trends of interest are in error.

##### Projections of Likely Output from Public Lands

The projections of likely future output from public lands are not statements of what will be or of what must be supplied from public lands. They are estimates of what is likely to be produced from public lands in the future, based upon extrapolations of what was produced from or consumed on these lands in the past, tempered by qualitative judgments of the impact of differing future conditions.

For several of the commodities considered, future production from public lands will be determined almost exclusively by prevailing economic conditions. In these cases, a qualitative discussion of possible future public land output is provided. Quantitative projections of output based on past production data alone would be nothing more than outright guesses and, therefore, are not provided.

##### Public Lands as a Future Commodity Supply Source

Each of the seven classes of commodities producible on public lands is the subject of a separate chapter of this report. Historical production trends and projections of national output and likely output from the public lands in 1980 and 2000 are summarized below.

##### Agricultural Crops and Forage

In 1964, 921 million of the 1,900 million acres of land in the 48 conterminous states were devoted to the production of agricultural crops and livestock grazing. Land use was nearly equally divided between agriculture and grazing. Agriculture accounts for 26 percent of the 1,900 million acres, grazing accounts for 23 percent. Including Alaska and Hawaii, 41 percent of the land area of the United States is used for agricultural production or grazing.

Federally owned lands are not a significant factor in agricultural production. For a hypothetical year during the period 1956-1968, 3,726 intensive



agriculture permits were issued for 596,680 acres of Western public land by Federal agencies. In contrast, Federally owned lands have been an historically important source of grazing forage for domestic livestock. Seventy-three percent of the public land in the West is used for livestock grazing during some part of the year. In 1947, 19 percent of the animal unit months (AUM's) of forage required to sustain the West's grazing livestock population was represented by the AUM's permitted on public lands. By 1966, only 12 percent of total Western forage requirements were supplied by public lands.

Projections of total land requirements for agriculture and forage and the probable future role of the Federal lands indicate that major deviations from the historical trends are not likely. Except in highly localized areas, there will be little pressure on the Federal lands for intensive agricultural uses by the year 2000. Only 2.2 million acres of uncropped arable Federal land in the West are currently suitable for intensive agriculture. The costs of developing these lands for production would be substantially higher than the costs of developing private lands or the costs of bringing back into production the approximately 61 million acres that have been diverted from crop production through government programs. Large acreages of Western public lands will continue to be used for livestock forage, but their relative importance to the grazing industry will decline. If past trends continue, less than 7 percent of the AUM's required by Western livestock will be obtained from Federal lands in the year 2000.

#### Fish and Wildlife Resources

The principal role of the Federal lands in the area of fish and wildlife is one of providing habitat. By developing and protecting the natural environment needed to sustain fish and wildlife, Federal land-managing agencies provide a service to two broad and overlapping classes of clientele--consumptive users and appreciative users. The consumptive-user group is composed mainly of sport fishermen and hunters. Appreciative users include bird watchers, wildlife photographers and others concerned with the welfare of fish and game simply because they are part of the natural environment.

In the 11 Western States and the 9 Eastern States where there are substantial acreages of Federal land, Federal lands provide habitat for between 40 and 48 percent of the big game animal population. Of the 316 million acres of

public land providing big game habitat, only 7 percent is closed to hunting. In the 11 Western States, an additional 17 million acres are technically open to hunters, but are made practically inaccessible by fences or adjacent private landowners who deny free access to recreationists. Approximately 8 percent of all the game and 35 percent of the big game harvested in the United States is taken on Federal land.

Federal ownership accounts for 45 percent of the cold and warm water fish habitat on the West Coast, 71 percent in the Mountain States and 15 percent in the Eastern States. Only five percent of the fishing waters on Federal lands are closed to fishermen, primarily for purposes of military security and protection for nesting waterfowl.

Projections of numbers of fishing- and hunting-license holders indicate that there will be 1.4 times as many hunters and 2.8 times as many fishermen in the United States in 2000 as there were in 1965. Participation in birdwatching and other wildlife-oriented recreation is expected to increase by 1.3 times over current participation. Demand for wildlife to observe and hunt and fishing waters to fish will increase accordingly.

What impact these trends will have on Federal lands is unknown. The only reasonable conclusion that can be drawn from available data is that pressures on Federal and state lands will increase at no less of a rate and probably at a greater rate than on private lands. How much of the burden will be assumed by Federal, as opposed to state agency lands, is a matter of public policy yet to be decided. For hunting at least, the current comparatively light harvest relative to game population on Federal lands indicates the ability of Federal lands to absorb additional hunting pressure.

#### Outdoor Recreation

There is no way to clearly and precisely relate outdoor recreation activity on the public lands to that on private lands. The Outdoor Recreation Resources Review Commission (ORRRC) estimated 4.3 billion occasions of participation in summertime outdoor recreation activities in 1960. Some 566 million recreation visits were reported by public agencies to ORRRC in 1960; and, since most visits involve several recreational activities, it may be deduced that a large portion of the total participation in outdoor recreation occurs on public lands. In turn, about 40 to 50 percent of the volume of outdoor recreation supplied by all categories of public lands is supplied by Federal lands.



To some extent, the features attracting outdoor recreation activity on the Federal lands are different from those available on lands held by state and local agencies and private enterprises. Some 360 million acres of Federal lands are classed by the managing agencies as suitable for recreation; nearly 5 million acres of water surface areas are included. The Federal lands have most of the large expanses of space desired for many recreation activities and the attractive natural settings. They include 12 million acres of outstanding natural areas, 45 million acres of primitive areas, and many of the spectacular land, water, and engineering features prized by recreationists. As a consequence, the demand for outdoor recreation on the Federal lands has built up somewhat independently of the demand for outdoor recreation elsewhere. Despite the concentration of the Federal lands in the West and in areas removed from the great population centers, the rate of increase in recreational visits to the Federal lands has exceeded the overall rate of increase in recreational activity.

The historical record of recreational visits from 1948 to 1967 to national parks, other Park Service areas, the national forests, and wildlife refuges shows a compound annual rate of increase in excess of 10 percent. National forests, with 11.8 percent, have the highest rate of increase.

The projection from 1965 to 2000 for these four categories of Federal lands indicates a 465-percent increase in recreational visits (291 million to 1,548 million). Large as the absolute increase is, it reflects a 4.9 percent annual rate of increase, in comparison with the historical rate of more than 10 percent. Realism in the 465-percent projected increase depends on a number of factors independent of the assumptions behind the projections: (1) the ability of the state lands to absorb an 880-percent projected increase in outdoor recreation, since any degree of failure here will tend to shift some demand to the Federal lands; (2) the ability of the Federal agencies to shift increased recreational activity as congestion builds up in preferred areas, to less preferred areas; (3) adequate investment by the Federal government in facilities and management needed to accommodate the projected volumes of recreational use; and (4) as land use conflicts develop, the commitment which Federal agencies will be willing to make to recreational use in view of major commitments to other resource demands.

#### Timber Products

United States timber production, in roundwood equivalents, moved from 10.8 billion cubic feet in 1947 to 11.8

billion in 1968, a nine percent increase. Net imports increased from 9 percent of consumption in 1947 to 14 percent in 1950; since then it has held steady at about 13 percent. The trend in consumption is similar to that in production since net imports did not vary sufficiently to affect general production-consumption relationships.

Assuming that net imports will remain relatively stable at 12 percent of consumption, overall timber production is projected (medium-level estimate) to increase from 11.8 billion cubic feet in 1968 to 17.1 billion in 1980 and 21 billion in 2000. Sawlog production is projected slightly downward, but veneer logs and pulpwood are projected upward (110 and 260 percent, respectively).

Federal lands contain 22 percent of the nation's 510 million acres of commercial forest, and state and local public lands account for 6 percent of the total. The Forest Service administers 96.8 million acres, or 85 percent of the total Federal commercial forest. The Bureau of Land Management administers a major share of the remaining Federal commercial forest.

The 298 billion cubic feet of timber volume on all public forests represents 42 percent of the nation's timber inventory. Sawtimber volume, estimated at 2,525 billion board feet, is 56 percent publicly owned. About 80 percent of the publicly owned timber--both total growing stock and sawtimber--is in the national forests. Most of the remaining Federal timber volume is on Bureau of Land Management lands.

Timber cut on Federal lands increased from 0.9 billion cubic feet in 1947 to 2.7 billion in 1968; the rates of increase were similar for the Forest Service (which accounted for nearly 90 percent of the Federal cut throughout 1947-1968) and the Bureau of Land Management. Since United States timber production increased 9 percent over the same time period, the Federal share of the total increased substantially --from 8 percent in 1947 to 23 percent in 1968.

If projected timber requirements in 1980 and 2000 are to be met, greatly increased yields will be required from Federal lands. Assuming production in the year 2000 of 6 billion cubic feet from industry lands (more than twice present levels), 8 billion cubic feet from private non-industrial lands (a 33 percent increase, contrasted with a 25 percent decline from 1947 to 1968), and 1.5 billion cubic feet from state and local public lands (nearly twice present levels) still leaves a minimum 5.5 billion cubic feet for



the Federal lands to supply if projected timber requirements are to be met.

The Federal lands will eventually sustain an annual harvest of 4 billion cubic feet under present levels of management, providing no further reservations of commercial forest land occur. Intensified timber management, extended to all Federal lands where at least a 6 percent rate of return on expenditures can be expected, would raise the sustainable annual harvest above 5.5 billion cubic feet. If the assumed production levels on non-Federal lands cannot be met, the Federal share will need to increase to meet projected consumption. If intensified timber management can be extended to all Federal lands where economically justified at 4 percent, the annual harvest from Federal lands can be raised to 7.6 billion cubic feet.

### Water

Water is the only commodity discussed in this report that is produced from virtually every acre of Federal land. This commodity is also unique in that its consumption on Federal lands can and does affect the amount of water that is available for use on non-Federal lands.

The long-term average annual water yield from Federal lands in the 11 Western States averages close to 62 percent of the 363 million acre-feet of water yielded from all lands. Forest Service and National Park Service lands are the major source of this yield, providing 54 percent of the total water yield in the Western States. In every Western State, public lands contribute more than half of the total water supply. Nearly 92 percent of the western population is currently dependent in some way upon water from Federal land.

Approximately 99 percent of the water produced from public lands is available for use on non-Federal lands. In 1967, natural and artificial consumptive water uses on Federal lands accounted for only 1 percent of the yield from these lands. Fish and Wildlife Service water uses account for 80 percent of all the water consumed on Federal land.

In 1965, water withdrawn for use from Western stream and ground sources totaled one-third of the average annual water yield in the West's eight water resource regions. Water consumption averaged 50 percent and ranged from 36 to 62 percent of withdrawals. Irrigation uses accounted for 92 percent of the water consumed in the West's eight water resource regions, compared with 50 percent for the rest of the nation.

Water Resource Council projections of water requirements show that the long-term average annual water yield in the West will exceed water withdrawals by 2.7 times in 1980 and by 1.5 times in 2000. Total consumptive use will increase by 32 percent by 1980 and by 62 percent by 2000. Estimated consumptive use on Federal lands in 2000 represents slightly more than 1 percent of the annual runoff from Federal lands.

The projections show that current regional water deficits will continue into the future, but these can continue to be met by importing water from the Upper Colorado region. Local water shortages may require more intensive watershed management on some Federal lands. In some areas, land uses that damage or destroy watershed values may have to be modified or prohibited.

### Energy Fuel Minerals

Between 1947 and 1965, United States consumption of power generated from fossil fuels, hydroelectric and nuclear sources has increased at an average rate of 3.0 percent per year. The fossil fuels--petroleum, natural gas and coal--have been the major input source of energy production. In 1947, fossil fuels accounted for 99.1 percent and hydroelectric power 0.9 percent of the energy supplied. By 1965, fossil fuel sources accounted for 98.7 percent, hydroelectric power 1.2 percent, and nuclear sources 0.1 percent of the total energy production.

Consumption of power is projected to increase from 54 quadrillion BTU's in 1965 to 91 quadrillion in 1980 and to 155 quadrillion in 2000. To supply future power requirements, fossil fuels are expected to be the input source of 86 percent of the BTU's consumed in 1980 and 82 percent in 2000. Hydroelectric power and nuclear power will provide 13 percent of the power required in 1980 and 18 percent in 2000.

The principal energy fuel resources owned by the United States government are crude petroleum (oil), natural gas (gas), oil shale, and geothermal steam. In 1947, the output of Federal lands leased for mineral production accounted for 4.9 percent of the petroleum produced in the United States, 3.2 percent of the natural gas liquids, 2.5 percent of the natural gas, and 1.3 percent of the bituminous coal. By 1967, these percentages had risen to 14.6 percent for petroleum, 3.9 percent for natural gas liquids, 13.2 percent for natural gas, and 1.6 percent for bituminous coal.

S-9



Production by outer continental shelf (OCS) leaseholders has been responsible for the largest part of the increasing importance of oil and gas from Federal lands. OCS petroleum production as a percent of total United States production increased from 0.9 percent in 1954 to 8.0 percent in 1967, while on-shore production increased from 4.0 percent to 6.6 percent. Gas production from the OCS has risen from 0.3 percent to 6.6 percent of national production, while on-shore leaseholder production increased from 2.2 percent to 6.6 percent.

If past growth rates continue into the future, the Federal lands will continue to be a major source of the gas and oil produced in the United States. However, just how much production will actually come from Federal lands is not known. The importance of leased Federal lands as a source of energy fuel will be dependent upon the extent of future discoveries and proof of reserves that will occur on Federal lands and the costs of production from these reserves relative to costs of production from non-Federal lands. Neither of these items has been projected in this report.

Bituminous coal production on Federal lands, both in absolute amount and as a percent of total United States production, is expected to increase only moderately in the future. Production of oil shale from the shale oil reserves owned by the government is not expected for technological reasons before 1980. Economic conditions will determine the amount, if any, of shale oil produced by the year 2000, although the Department of Interior has developed specific unpublished projections showing 350 million barrels of shale oil production by the year 2000.

#### Nonfuel Minerals

For purposes of discussion, nonfuel minerals produced from public lands are broadly divided into minerals consumed primarily in world fertilizer markets and other selected minerals and metals. Minerals used in fertilizers include phosphates, potassium, sodium and sulfur. The metals and other minerals reviewed are iron and steel, copper, lead, magnesium, mercury, nickel, molybdenum, tungsten, vanadium, diatomite, and sand and gravel.

The relative shares of production accounted for by output from Federal lands is reviewed for only a selected group of minerals. These are the minerals that are leased under the Mineral Leasing Act (phosphates, potassium, sodium and sulphur), Outer Continental Shelf Act (sulfur), and the Acquired Lands Leasing Act (copper and lead in the Eastern United States), or sold under the "Common Varieties" Act (stone, gravel and similar materials).

The remaining nine minerals and copper and lead in the West are "locatables" and are not produced on public lands per se. Most of the metalliferous minerals discovered on public land are acquired by private parties by location under the provisions of the Mining Laws of 1872. Production from mining claims and patented public land is not considered as Federal production, but rather as production from private lands. In addition to the metals, sulfur is also produced from both patented and nonpatented mining claims.

All of the phosphate rock production from the leased public domain comes from leaseholders in Idaho and Montana. Approximately 6 percent of the total United States output of phosphate came from these lands in 1967, up from about 2 percent in 1947. Some phosphate is also produced from leased acquired Federal land in Florida, but the output represents a negligible factor in national production.

Potash produced principally from leased public domain in New Mexico plus a small amount of production in California has accounted for between 75 and 95 percent of national domestic production since 1960. How much of this production enters the nation's markets is not known.

Sulfur production from outer continental shelf leases began in 1960. By 1966, production from OCS leases accounted for 17 percent of total national output. Sodium production from the public domain accounted for about 8 percent of national production in 1947, but has declined in importance to less than half of one percent in 1967.

Lead and copper have been produced since 1961 and 1966, respectively, by leaseholders of acquired Federal land in Missouri. Production of both of these metals has consistently represented less than half of one percent of national production.

Sand and gravel production from acquired lands has been erratic, but it has risen from 4,000 tons in 1950 to a record high of 5 million tons in 1967. Sand, gravel and other industrial and construction materials occurring on Federal lands are also disposed of under the provisions of the Mineral Disposal Act of 1947, as amended by the "Common Varieties" Act of 1955. Under the provisions of this act, \$93,600 worth of industrial materials were sold by contract in 1968; an additional \$1.7 million worth of these materials was given to Federal agencies and nonprofit organizations through 323 free-use permits. All free-use permits and sales were in the 11 Western States.



The role of the Federal lands as a future supply source of leasable and locatable minerals is uncertain. Although approximately half of the mineral lands in production today are known to have been acquired under the Mining Laws, there are no historical data on the production of locatables to indicate the relative importance of Federal lands as a source of metal and locatable mineral production. For the leasable minerals, it is expected that Federal land will continue to grow in importance as a source of phosphate rock, potash and sulfur. However, it is impossible to project the relative shares of production that will come from Federal lands because of the largely unknown nature of the mineral resources and their characteristics on these lands.

#### Policy Implications of the Demand Projection

The policy questions raised by the projections given above concern what the entire set of projections may imply in relation to the possible effects of alternative government policies affecting levels of output for individual commodities. This aspect of government policy is distinct from policy questions regarding the production of individual commodities, questions as to whether actual production of the projected future demands will be in the public interest, and the desirability of attainment of the projected output level for one commodity over another when future conflicts in use appear probable. Alternatives to current government policy relating to specific commodity areas are discussed in the commodity studies prepared for the Public Land Law Review Commission. Defining the public interest would require detailed knowledge of the economic impact of alternative levels of output of individual commodities upon different segments of the United States economy and a precise identification of those interests that are to be served by public land management. Both of these items are subjects of other studies being undertaken by the PLLRC.

The previously developed projections of commodity requirements from all lands and the likely future role of the public lands as a supplier of these commodities are summarized in Table 1. For purposes of comparison, the projections are shown as indexes of projected output with current production or use equal to an index value of 100.

For wildlife habitat, energy fuel minerals and nonfuel minerals, available data did not permit meaningful projections for the public lands as distinct from all lands. The projection indexes shown for public land production of these commodities given in Table 1 are enclosed in parentheses to

Table 1.--Indexes of Medium Level Projections of Total Future Requirements for the Likely Output from the Federal Lands for Selected Goods and Services, 1980 and 2000

(Current index value is 100)<sup>a/</sup>

Item	Total Requirements		Output from Federal Land	
	1980	2000	1980	2000
Agricultural cropland <sup>b/</sup>	100	100	100	100
Livestock forage <sup>c/</sup>	131	183	77	55
Wildlife habitat <sup>d/</sup>	128	173	(128) <sup>i/</sup>	(173)
Outdoor recreation <sup>e/</sup>	160	241	242	465
Timber <sup>f/</sup>	145	178	165	204
Water <sup>g/</sup>	132	162	130	240
Energy fuel minerals <sup>h/</sup>	152	242	(152)	(242)
Nonfuel minerals <sup>i/</sup>	177	336	(177)	(336)

<sup>a/</sup> The year used to represent "current" production varies by commodity from 1965 to 1968.

<sup>b/</sup> Cropland requirements in the 11 Western States.

<sup>c/</sup> Animal unit months of forage required by domestic livestock in 11 Western States assuming that national forage requirements will increase at a compound rate of 1.8 percent per year from 1966 to 2000.

<sup>d/</sup> Expected increases in hunting license sale in the 11 Western States. The indexes for 1980 and 2000 fishing license sales in the West are 167 and 325, respectively.

<sup>e/</sup> Participation in major outdoor recreation activities. For Federal lands, recreation visits to national parks, other Park Service areas, the national forests and wildlife refuges.

<sup>f/</sup> Timber products production. Indexes of production on Federal land assume that these lands will supply 26 percent of national output.

<sup>g/</sup> Indexes for "total requirements" are water consumption in the eight water resource regions in the West; for "Federal land," data for water withdrawals in the same water resource regions.

<sup>h/</sup> BTU's of power to be produced from oil, gas and coal.

<sup>i/</sup> Tons of phosphate rock, potash and sulphur needed for domestic consumption or export.

<sup>j/</sup> Index numbers in parentheses are identical to those given in the "total requirements" column. Federal lands are expected to be an increasingly important source of wildlife habitat and minerals, but sufficient data are not available to provide indicators of how total future demands will be allocated between Federal and all other lands.



indicate that they are identical to the projections of production from all lands and are not directly comparable with other items in the public land columns. The use of total requirement projections for public land output is not meant to imply that the public lands will continue to supply the same percentage share of output as they currently provide. Public lands are expected to become an increasingly important source of wildlife habitat and minerals, but the magnitude of the change in relative importance is not identifiable.

The major policy implication of the projections summarized in Table 1 is that conflicts between alternative uses of public lands will intensify. The most likely sources of major conflict center around the production of water, outdoor recreation opportunities, timber and minerals. Production of these commodities from public lands is expected to be from 2.0 to 4.6 times as great in 2000 as they are now. In some respects, each of these uses is or will be incompatible with other uses and will require policy decisions to establish priority of use. Attainment of the projected level of output for any one of these commodities could require some withdrawal of public land for exclusive production, as it is probably impossible to meet all of the projections under current policy and land use patterns. If these withdrawals are large, the production of other commodities at the projected levels will require sufficient funds to undertake intensification of management activities over and above those required just to meet the projected output levels.

The projected 465-percent increase in outdoor recreation by 2000 refers to recreational visits to national parks, other Park Service areas, and the national forests and wildlife refuges. Recreational use of other Federal lands was not specifically considered, but it may be expected to increase proportionately. This projection is nearly twice the projected level of nationwide participation in outdoor recreation activities but substantially lower than the projected increase of 880 percent in outdoor recreation on state lands. To provide for the projected increase in use in a manner that will not reduce the recreational attractiveness of these Federal areas because of visitor congestion, a large portion of the projected increase in visits must be accommodated on areas not currently used for recreation purposes. If the projected 465-percent increase in outdoor recreation on public land is to be realized, large investments in new facilities will be required to accommodate more intensive recreation and conflicts with other land uses will have to be resolved. Resolution of the conflicts may mean less water, timber, forage or other resources than could be produced under specific management for a particular use. But it may also mean that less recreation will be

S-14

supplied that requires extensive land areas, particularly the dedication of additional land to designated primitive and wilderness areas which require the exclusion of other land uses.

The year 2000 projections for timber indicate that the public lands will become increasingly important as a source of timber. Probable demands on public lands will require a 204-percent increase in public land timber production, as compared with a 178-percent increase for all ownership sources. The projected increase for public lands is a physically attainable level of production if no further reservations of commercial timber land for recreation and other purposes occur. Adequate funds and personnel will also have to be available to permit the intensification of timber management required to provide this level of output. Should further withdrawals of commercial forest land or other timber cutting restrictions be made to meet requirements for recreation, watershed or other purposes, the need for intensive management on remaining lands will increase further, as will Federal agency budget requirements, if a 204-percent increase is to be achieved.

As shown by Table 1, water withdrawals in the West's eight water resource regions are expected to increase by 1.3 times by 1980 and by 2.4 times by 2000. Since Federal lands in the West supply close to 62 percent of the water yielded from all lands, the pressure on these lands for water production will increase proportionately. Although the long-term water yield in the West is expected to exceed withdrawals by 1.5 times in the year 2000, local shortages will continue. The local shortages may require more intensive watershed management on Federal lands. In some areas, land uses that damage or destroy watershed values may have to be curtailed or prohibited if, again, the projected level of output from Federal lands is to be met.

The role of the Federal lands as a future supply source of energy and nonfuel minerals is uncertain. Increasing national requirements would indicate that in the year 2000 2.4 times as much fuel mineral production and 3.6 times as much nonfuel mineral production will occur on public lands as occurs now, assuming no change in the relative importance of public lands as a supply source. Under the existing laws affecting the exploitation of minerals on public land, mineral interests are afforded favorable treatment compared with other users and potential users of Federal lands. A continuation of the policies prescribed by these laws would indicate that if the proper economic conditions exist for mineral production from public lands, needed production would be forthcoming. However, the magnitude of the

S-15



projections of uses of Federal land for recreational opportunities, timber and water production, and the growing national concern with the quality of environment may prove to be incompatible with mineral production on some areas of public land. Given these pressures, public policy may dictate that more Federal land be withdrawn from mineral exploitation than is now possible through lease or mining entry. If this occurs, the potential for mineral production from leased and patented Federal land could decrease, simply because there will be less public land available for exploitation by mining and mineral interests.

Major new conflicts are not expected to arise from the future use of the public lands for intensive agriculture and livestock forage production. Future use of public land for agriculture is expected to remain constant and the relative importance of public lands as a source of livestock forage will decline. Similarly, future demand for use of the Federal lands as wildlife habitat is not expected to have particularly significant nationwide effects on other uses of public lands. With adequate funding of wildlife programs, wildlife habitat maintenance can be complementary with the production of other goods and services.

In addition to the potential conflicts noted above, the future disposal or use of public lands for occupancy uses could have a significant impact upon the realization of the commodity projections. Occupancy uses encompass such uses of the spatial values of public lands as rights-of-way, governmental, residential, commercial and similar uses. Although these uses were not specifically covered in this study, they are expected to increase, and are likely to have higher social, economic, or political value than many other future uses of public lands. Future occupancy uses of Federal lands will, therefore, place additional constraints upon attainment of the projected levels of output from Federal lands for the seven commodity areas considered.

## CHAPTER I

### INTRODUCTION

The Public Land Law Review Commission, established by the Act of September 19, 1964,<sup>1/</sup> has the statutory responsibility to: (1) "study existing statutes and regulations governing the retention, management, and disposition of the public lands"; (2) "review the policies and practices of the Federal agencies charged with administrative jurisdiction over such lands insofar as such policies and practices relate to the retention, management, and disposition of these lands"; and (3) "compile data necessary to understand and determine the various demands on the public lands which now exist and which are likely to exist in the foreseeable future."

This is one of a series of studies designed to provide a basis for carrying out the statutory directive that the Commission recommend to the President and the Congress "such modifications in existing laws, regulations, policies, and practices as will, in the judgement of the Commission, best serve to carry out the policy" that "the public lands of the United States shall be (a) retained and managed or (b) disposed of, all in a manner to provide the maximum benefit for the general public."

The future potential use of the public lands is a central focus of the entire study program. This study draws upon the specific subject matter developed elsewhere in the PLLRC study program. It attempts to draw these materials together and to provide a broad analysis of the historical use of the public lands, the likely future trends in the potential production from them and the alternative opportunities of these lands to contribute to the national supply of those commodities producible on the public lands.

The study report on Projections of the Consumption of Commodities Producible on the Public Lands of the United States, prepared for the PLLRC by Robert R. Nathan Associates,

<sup>1/</sup>Pub. L. No. 88-606, 78 Stat. 982, amended Pub. L. 90-213, 81 Stat. 660, 43 U.S.C. §§ 1391-1400 (1968 Supp.).



Inc., is used where possible as a source of estimates of future national demands. The individual commodity studies prepared for the Commission and other published and unpublished reports provide the source of information about the relationships between national demand and the role of the public lands as a source of supply.

#### Objectives

The objective of this study is to analyze and discuss the probable future demands on the public lands as a source of supply of various commodities and the possible effects of alternative government policies affecting levels of output or use of the public lands for supplying these commodities. Four subsidiary objectives are to:

- (1) Assemble information on the actual past commodity output of the public lands nationally, and where feasible, by region and state.
- (2) Assemble information on the total national supply (net domestic production plus imports) of each commodity for the period 1947-1968 and identify the relative role of the public lands in meeting national supply.
- (3) Assemble information relating to the probable future output potential of public lands based on productivity and inventory estimates now available.
- (4) Compare the Nathan Report projections of future aggregate consumption levels with other available projections, including the basic assumptions used in each.

#### Scope of the Study

##### Commodities and Uses

The commodities and uses covered in this study are:

- (1) agricultural crops and forage; (2) game and sport fish; (3) outdoor recreation; (4) timber; (5) water; (6) energy fuel minerals; and (7) nonfuel minerals. A separate chapter is devoted to each of these areas.

The completed PLLRC commodity reports for outdoor recreation and nonfuel minerals were not available at the time this report was prepared. Those portions of these studies

that were available were used in the analysis. The completed commodity studies may contain more information about the past and future role of likely Federal lands as a supply source of outdoor recreation and non-fuel minerals than is indicated by the respective analyses provided in this report.

Occupancy uses of Federal lands were also scheduled for discussion, but this commodity area has been omitted because of the unavailability of the PLLRC study of use and occupancy of Federal lands. Occupancy uses encompass a variety of uses of the spatial values of the public lands. These include power line, pipe line, and highway rights-of-way; Federal military and nonmilitary, and state and local government uses; and residential, commercial, industrial and municipal uses. The future disposal or use of public lands by permit, license, lease or other formal document for occupancy uses could have a significant impact upon the realization of the projections of the likely role of the public lands as a supply source for the seven commodities discussed in this report. Occupancy uses are likely to increase in the future, and to have higher social, economic or political values than many other future uses of Federal land. Future occupancy uses of Federal lands may, therefore, place significant constraints upon attainment of the projected levels of output from Federal lands for the seven commodity areas considered.

#### Federal Lands

The Federally owned lands of concern in this report are the lands defined by Section 10 of Public Law 88-606 and other Federal lands which have characteristics similar to, or are managed in conjunction with Section 10 lands. The lands defined by Section 10 of Public Law 88-606 are: (a) the public domain of the United States; (b) reservations, other than Indian reservations, created from the public domain; (c) lands permanently or temporarily withdrawn, reserved, or withheld from private appropriation and disposal under the public land laws, including the mining laws; (d) outstanding interests of the United States in lands patented, conveyed in fee or otherwise, under the public land laws; (e) national forests; (f) wildlife refuges and ranges, and (g) the disposition or restriction on disposition of the mineral resources in lands defined by appropriate statute, treaty, or judicial determination as being under the control of the United States in the outer continental shelf.



### Concepts of Supply and Demand

Unless otherwise noted, the terms "supply" and "demand" are used in this study in a conventional non-economic sense. When referring to the past or present, "supply" is the amount of a good or service that has been or is available for suppliers for use or consumption. Historical or current "demand" is the quantity of a good or service that has been or is used, enjoyed or consumed by consumers. These definitions ignore the impact of costs and prices to the extent that costs of production and price of commodities consumed or used is not explicitly considered.

The same definitional format is followed when discussing the future. An estimate of future supply is an estimate of the quantity of a good or service that will be physically available from supplies for consumption or use in the future. Future demand is defined as the amount of a commodity that will be consumed by consumers at some specified date. Two assumptions are implicit in these definitions. Future supply (availability) estimates are made under the assumption that when there is a cost associated with the production of a commodity, consumers will be willing to bear these costs, either as individual costs or as social costs. Estimates of future demand (requirements) are made with the assumption that adequate supplies of required commodities are available at prices that consumers individually or as a society are willing to pay.

### Projections of Future Consumption Requirements

The purpose of reviewing projections of future national demands or consumption requirements for the commodities discussed in this report is to determine the direction and the magnitude of future trends in the relative importance of the public lands as a source of commodity supply. In some instances, the measures of relative change are derived from highly quantified projections of individual commodities. In others, qualitative assessment of the implications of past trends is the only information available for projecting future trends.

Most of the demand projections provided are for aggregations of individual products or services, and pertain to either national or regional markets. Projections of individual commodities and for localized areas are provided only when such projections were considered in the commodity reports prepared in other studies undertaken by the Public Land Law Review Commission.

The demand projections reviewed are not the only projections available, and they may not be what some analysts consider as the best projections available. However, the projections provided serve the purpose of indicating future trends. Other available projections generally do not differ radically enough from those used to indicate that the derived broad relative trends of interest are in error.

### Projections of "Demands" on the Public Lands

The projections of probable future demands on public lands presented in the report are not predictions. That is, they are not statements of what will be or of what must be supplied from public lands. They are simply estimates of what is likely to be required from public lands in the future, based upon extrapolations of what was produced from or consumed on these lands in the past, tempered by qualitative or quantitative judgments of the impact of differing future conditions.

The actual future role of the public lands as a source of commodity supply will be determined by complex, interrelated sets of institutional and economic factors. The principal institutional factor is future public land management policy affecting the use of public lands for the production of various commodities and the conditions under which these commodities will be made available to consumers. The projections of the likely future output from public lands assume that there will be no significant changes in public policy other than those shown to be occurring by historical trends. To assume otherwise would require knowledge of the recommendations that will be made by the Public Land Law Review Commission and of the policy changing legislation that will be enacted by Congress in response to these recommendations. However, an effort has been made to note when the data examined indicate that a continuation of current land management policy will be inadequate, given potential future uses of public lands. Specifically, when projection data indicate that two or more likely future uses of public lands will be in conflict, this is noted.

As is the case now, economic conditions rather than public policy will determine the actual future consumption of commodities produced on public lands. Future public land policy will determine only the amounts and conditions under which various commodities will be made available to prospective consumers. The actual level of consumption will be determined by the amounts and prices of these commodities that are available from both Federal and non-Federal lands, and by prevailing economic demand conditions.



The future economic conditions that will determine output from public lands are as undefinable as future policy. In fact, there is even less information available about the possible nature of future economic conditions than there is about future institutional factors. Past public land management policy can be documented from historical records. The strictly economic supply and demand factors that have been responsible for past consumption of products available from public lands have not been precisely identified and therefore cannot be projected.

For several of the commodities considered in this report, it is shown that future production from public lands will be determined almost exclusively by prevailing economic conditions. In these cases, a qualitative discussion of possible future public land output is provided. Quantitative projections of requirements based on past production data alone would be nothing more than outright guesses and therefore are not provided.

## CHAPTER II

### AGRICULTURE AND FORAGE

The use of land for the production of agricultural crops and for grazing in the United States has been relatively constant since 1920. In 1964, 921 million of the 1,900 million acres of land in the 48 conterminous states were devoted to these uses. Land use was nearly equally divided between agriculture and grazing; agriculture accounted for 26 percent, grazing 23 percent. Including Alaska and Hawaii, 41 percent of the 2,266 million acres of<sup>1/</sup> total land area is devoted to agriculture and grazing (10).<sup>1/</sup>

Federally owned lands are not a significant factor in total agricultural production. Less than a million acres of Federal land is leased for intensive agriculture. In contrast, however, public lands have been an historically important source of grazing forage for domestic livestock, particularly in the 11 Western States.

Projection of total land requirements and the probable future role of the Federal lands indicate that major deviations from these trends are not likely. As documented in the following discussion, there will be relatively little pressure on the public lands for intensive agricultural uses by the year 2000. Large acreages of these lands will continue to be used for livestock forage in the 11 Western States, but their importance to the grazing industry will decline.

#### Agriculture

##### United States Production Trends and Land Use

Over the last two decades, the food and fiber requirements for domestic use and export have increased considerably.

<sup>1/</sup>Figures in brackets refer to the Literature Cited at the end of each chapter.



At the same time, the use of cropland for crop production has declined. Between 1950 and 1968, total United States population increased by 32 percent. Per capita food consumption has also increased, resulting in a 36 percent increase in total food consumption since 1950. During this same time period, the amount of cropland used for crops declined by 10 percent (Table 1). This decline in land use has occurred despite a significant increase in the amount of cropland harvested for export, as shown by the following data (10):

	1955	1967
	(Million acres)	
Total United States cropland harvested	340	308
Cropland harvested for export	47	71
Net domestic harvest	293	237

The explanation of these trends is the increased efficiency of United States agriculture and imports. The 10 percent decline in the amount of cropland used for crops since 1950 has been coupled with a 52 percent increase in crop production per acre, resulting in a 42 percent net increase in agricultural output. These trends are illustrated in Table 1.

Although the United States is a net exporter of agricultural products, agricultural imports help to reduce the pressure upon domestic lands for production. In 1967, the United States exported \$6.4 billion and imported \$4.5 billion worth of agricultural products. Forty percent of the value of imports was represented by products not commercially produced domestically, such as rubber, coffee, and bananas. Commodities commercially produced in the United States represent 60 percent of the value of imports (9). Thus, in terms of products commercially produced in the United States, net exports amount to \$2.7 billion worth of goods.

The above-noted decline in the acreage of cropland used for crops is partially a result of economic forces operating in the agricultural economy. Government diversion programs, however, have been the principal cause of the decline of producing acres. In 1965, there were 56 million acres of cropland that were idle or in cover crops (6). This is more than two-and-a-half times the acreage of idle cropland that existed in 1950.

The impact of government diversion programs is shown in Table 2. As of 1966, the last year for which data are available, 60.6 million acres of land were diverted from

Table 1.--Trends in Population and Crop and Livestock Production, United States, 1950-1968  
(Index Numbers)

Item	1950	1955	1960	1965	1968
Population	100	109	119	128	132
Farm output	100	112	123	133	142
Livestock production	100	112	116	126	134
Crop production	100	108	121	129	137
Crop production per acre	100	108	130	145	152
Cropland used for crops	100	100	93	89	90

Source: (6).



Table 2.--Land Diverted from Crop Production by Government  
Production or Conservation Programs, 1956-1966  
(Million acres)

Year	Acreage Reserve	Conser- vation Reserve	Feed Grain	Wheat	Cotton	Crop- land Conver- sion	Crop- land Adjust- ments	Total a/
1956	12.2	1.4	...	...	...	...	...	13.6
1957	21.4	6.4	...	...	...	...	...	27.8
1958	17.2	9.9	...	...	...	...	...	27.1
1959	...	22.5	...	...	...	...	...	22.5
1960	...	28.7	...	...	...	...	...	28.7
1961	...	28.5	25.2	...	...	...	...	53.7
1962	...	25.8	28.2	10.7	...	...	...	64.7
1963	...	24.3	24.5	7.2	...	0.1	...	56.1
1964	...	17.4	32.4	5.1	0.5 <sup>b/</sup>	0.1	...	55.5
1965	...	14.0	34.8	7.2	1.0 <sup>b/</sup>	0.4	...	57.4
1966	...	13.3	32.0	8.2	4.7	0.4	2.0	60.6

a/ Total diverted including acreage devoted to substitute crops.

b/ Not required to be put to conserving uses.

Source: (8).

agricultural production under government programs. The majority of the government withdrawn land has not been put into uses which would preclude their being brought back into production in the future.

#### Land Needed for Agriculture in 1980 and 2000

The amount of land needed for food and fiber production in the United States in 1980 and 2000 will be determined by: (1) future population, (2) per capita consumption, (3) livestock feed requirements, (4) imports and exports, and (5) crop yields per acre.

The implication of projections of these factors for agriculture have been the subject of recent studies by Robert R. Nathan Associates (5), South Dakota State University (6), and Earl O. Heady and Leo V. Mayer (3). The Nathan and South Dakota State University projections were developed under contracts with the Public Land Law Review Commission. The study by Heady and Mayer, originally prepared for the National Advisory Commission on Food and Fiber, provides the 1980 projections cited in the South Dakota report.

Heady and Mayer's projections of 1980 agricultural land needs and South Dakota's projections for the year 2000 are given below. For purposes of comparison, projections of land needs for agriculture made by Hans Landsberg and others (4) for Resources for the Future (RFF) are also given. Because the Nathan Associates' projections of domestic and export consumption needs are in terms of consumption requirements rather than in terms of acreage requirements, these projections are not considered in this report.

#### Cropland needs, 1980

Heady and Mayer's study of 1980 cropland needs is based on an expected population of 243.4 million, estimates of per capita consumption, livestock feed requirements, expected exports, and crop yields per acre. Projections of cropland needs were derived for seven major crops under seven possible

2/ RFF projection assumptions about future population, yields, exports and other factors differ somewhat from the basic assumptions underlying the Heady and Mayer and South Dakota projections. Differences in these basic assumptions prohibit absolute comparisons of final projections.



market situations. For each crop, the maximum cropland available in the future was assumed to be equal to the maximum acreages that have been harvested in the past. This maximum acreage was defined as the sum of lands actually harvested in 1965 and associated available but idle cropland. For all seven crops, it is assumed that no more than 251.2 million acres will be available in 1980.

The seven crops considered were wheat, soybeans, cotton, and the four principal feed grains--corn, oats, barley and grain sorghum. Lands devoted to tame hay, fruits, vegetables, nuts and other minor crops were not considered. The exclusion of these crops is considered not to significantly affect the results of the analysis.

The seven market conditions analyzed include four "free market" and three "controlled market" programs that incorporate hypothetical but feasible export programs. For both the free and the controlled market conditions, several possible export policies are considered.

Projections of acreage needs for anticipated 1980 projection of wheat, feed grains, soybeans, and cotton under each of the market plans and associated export policies are given in Table 3. Assuming that 251.2 million acres will be available for the projection of these crops in 1980, Heady and Mayer concluded that the only market condition that would absorb this acreage would be the unrealistic condition of no market controls and the dumping of exports. The remaining three free market conditions would leave between 19 and 31 percent, or 48.0 and 78.4 million acres of the available 251.2 million acres idle. Under the three controlled market programs, the extent of idle lands ranges from 38.0 to 71.3 million acres, representing between 15 and 28 percent of the available acreage.

The possible use of idle cropland for pasture and minor crops was also considered by Heady and Mayer. They concluded that even given anticipated use of idle land for pasture, between 37 and 39 million acres of idle cropland would remain. The 251.2 million acres of available cropland for the seven major crops used in the analysis does not include croplands harvested for vegetables, fruits and nuts. In 1967, harvest of these crops covered 6.6 million acres. Even if one assumes that by 1980 this acreage were to triple and that future cropland needs would be obtained from the 56 million acres of idle cropland that could be used for the production of the seven major crops, there would still be substantial acreages of idle land.

The Landsberg et al RFF projections for 1980 are surprisingly close to those made by Heady and Mayer. The RFF

Table 3.--Major Crops and Idle Land, United States, 1965, with Projections for 1980 under Seven Market Situations<sup>a/</sup> (Million Acres)

Market Plan	Wheat	Feed Grains	Soy-Beans	Cotton	Idle Land
<u>Present Plan, 1965</u>	49.3	99.0	34.6	13.6	56.0
<u>"Free Markets," 1980</u>					
A. Cotton acreage controls; exports at 1965 level	59.7	73.9	29.3	10.0	78.4
B. Cotton acreage controls; exports at 1950-65 trend	69.4	81.0	42.5	11.3	47.0
C. No controls; exports at 1950-65 trend	70.0	81.2	42.6	9.3	48.0
D. No controls; export dumping	88.7	94.4	58.6	9.7	0.0
<u>Controlled Markets, 1980</u>					
E. Feed-grain program exports at 1950-65 trend	62.5	89.2	43.1	11.0	45.6
F. Acreage quotas; exports at 1950-65 trend	63.2	96.4	42.2	11.5	38.0
G. Acreage quotas; commercial exports only	42.2	93.7	33.8	10.3	71.3

<sup>a/</sup> Assumes 251.2 million acres are used for these crops. Feed grains include corn, oats, barley, and sorghum. Hay and minor crops omitted.

Source: Heady and Mayer (3), Tables 7, 11, 15, 19, 23, 27, and 31.



projections are based on substantially lower estimates of future yields per acre and per capita consumption, but on a population estimate that is 1.7 million higher. Based on the similarity of findings, these and other differences apparently are somewhat compensating. RFF projects 1980 acreage requirements for wheat, feed grains, soybeans and cotton to total 196 million acres. Minor crops and cropland pasture use are expected to require an additional 112 million acres, leaving an estimated total of 72 million acres either in fallow, idle or crop failure, or excess cropland. The estimated 72 million acres of nonproducing cropland are based on an assumption that the total cropland available in 1980 will be equal to 470 million acres, the average of cropland available in 1950 and 1954. By 1964, the acreage of available cropland declined to 440 million acres. Using the 1964 estimates of cropland acreages of 440 million acres as that which will be available in 1980 and the RFF estimates of 1980 land needs, the total area of nonproducing croplands is 42 million acres.

#### Cropland Needs, 2000

The South Dakota report gives only brief attention to land needs for intensive agriculture in 2000. The conventional approach of estimating total future food and fiber requirements, exports, yields and the like was abandoned in favor of a simpler approach. Starting from the base of an anticipated population increase of 73 percent by 2000 (Bureau of Census medium-high projection), a general assessment was made of the adequacy of current agricultural land resource to support this population. Land resource data were obtained from the 1958 National Inventory of Soil and Water Conservation Needs, as summarized in Table 4.

Based on the data presented in Table 4, the authors of the South Dakota report concluded that the United States will have little trouble meeting the agricultural land needs in the year 2000. They reason that since only about 300 million acres<sup>3/</sup> of the 638 million acres of nonfederal land suitable for regular crop production are actually in use, the acreage of cropland regularly harvested could be increased by 112 percent. Thus, even if the future yields on these additional lands were considerably below the current national average yields, there would be ample production to meet future needs. If the need should arise, an additional 169 million acres of available cropland suitable for intermittent agricultural production could also be brought into production.

<sup>3/</sup>This figure apparently excludes crop failures and cultivated summer fallow.

Table 4.--Non-Federal, Non-Urban Lands Suitable for Crop Production in the United States, 1958<sup>a/</sup>  
(Million Acres)

Present Use	Lands Suitable for Crop Production		
	Regular Use	Intermittent Use	Total
Cropland	373	49	422
Pasture and range	113	54	167
Forest and woodland	125	58	183
Other uses	26	8	34
Total	638	196	807

<sup>a/</sup> Includes Hawaii and Alaska.

Source: United States Department of Agriculture, National Inventory of Soil and Water Conservation Needs, Soil Conservation Service, 1958, as published in Food and Fiber for the Future (p. 245), and cited in (6).



The 1963 RFF projections of acreage requirements for 2000 are more definitive. The population estimate used by RFF for 2000 is 331 million. This is 23 million higher than the 1967 Series P-25 Census Bureau medium-high (Series C) projection of 308 million (5). RFF estimates that 436 million acres will be needed for crops by 2000. An additional 40 million is assumed to be needed for fallow and crop failures. Thus, if the 440 million acres of land devoted to agriculture in 1964 are all that will be available in 2000, there will be an apparent deficit of 36 million acres. However, as shown in Table 4, there are 638 million acres of non-Federal lands suitable for regular agricultural use. Subtracting the 440 million acres that are currently in use, leaves a total of 198 million acres that can be brought into production if market conditions warrant such use. Moreover, as indicated earlier, RFF's 1963 estimates of crop yields per acre are considerably below crop yield predictions developed by Heady and Mayer. Increased crop yields will reduce the future acreage requirement.

#### Potential Use of Federal Lands for Intensive Agriculture

Federal land managing agencies are not directly engaged in the production of agricultural crops other than grazing forage.<sup>4/</sup> Government lands that are used for intensive agriculture are brought into production by private operators under permit or lease from Federal agencies.

In the 17 Western states, 371.3 million acres or 32 percent of the total land area is Federally owned. Of this area, 38.4 million acres are estimated as being potentially suitable for intensive agriculture. This acreage is distributed among the following three classes of suitability:

Class	Description	Million Acres
A	Dry land--suitable for production	2.0
B	Irrigable--water potentially available	1.3
C	Irrigable--water not legally or physically available	35.1
Total		38.4

<sup>4/</sup>An exception is the small amount of land under intensive cultivation by the Bureau of Sport Fisheries and Wildlife for wildlife forage production.

A summary of the Federal agencies administering these lands is given in Table 5. The location of these lands by state is shown by Table 6.

#### Historical Use of Federal Lands in the West

Annual data describing the historical use of Western Federal lands for intensive agriculture are not available. However, data compiled for the PLLRC by South Dakota University for a hypothetical year during the period 1957-1968, shows that 596,680 acres of Federal land were used annually for intensive agriculture under permit. The number of permits and associated annual rent are shown in Table 7. Data were not available to permit an accurate breakdown of permits by agency for the hypothetical year.

Problems encountered during attempts to quantify agricultural use illustrate the relatively minor role of agricultural production as a use of Federal lands. The acreage under permit or lease during the hypothetical year referred to above represents less than two-tenths of one percent of the total Federal land and only 30 percent of Federal land currently estimated as suitable for agricultural production in the West.

The explanation of these low-use levels is found in the history of Federal land disposal policies and the land management objectives of the controlling agencies. Nearly all of the Western lands suitable for intensive agriculture have been transferred to non-Federal owners through various land grants and other land disposal programs. Moreover, much of the suitable land remaining in Federal ownership is in small, isolated, and often irregular tracts in mountainous and other relatively inaccessible areas.

Agriculture use permits are issued only when such action will contribute to the principal objectives of the managing agencies. This has been clearly shown by the review of regulations presented in the South Dakota report on the "Federal Land Laws and Policies Relating to Intensive Agriculture." As shown in Table 5, the following four agencies account for 97 percent of the total Federal lands currently suitable for intensive agriculture (Class A lands): Bureau of Land Management, Forest Service, Bureau of Sport Fisheries, and the Department of Defense, including the Corps of Engineers. Each of these agencies leases lands only when such action is consistent with the achievement of their management objectives. None has as an objective the production of agricultural crops.



Table 5.--Federal Public Lands Estimated Suitable for Dry-  
land or Irrigated Crop Production in 17 Western  
States, by Agency, 1968  
(Millions of Acres)

Agency	Total Federal Lands	Federal Lands--Arable <sup>a/</sup>		
		Dryland (Class A)	Irrig. (Class B) <sup>b/</sup>	Irrig. (Class C) <sup>c/</sup>
Bureau of Land Management	174.9	0.6	0.5	28.4
Forest Service	143.8	0.8	0.1	0.9
Bureau of Reclamation	9.0	d/	0.4	0.4
National Park Service	12.9	d/	d/	0.7
Bureau of Sport Fish- eries and Wildlife	6.5	0.1	0.1	0.1
Department of Defense	17.4	0.3	0.1	4.6
Corps of Engineers	3.7	0.1	d/	d/
Agency Not Determined	3.2	...	...	...
<b>Total Acres</b>	<b>371.3</b>	<b>2.0</b>	<b>1.3</b>	<b>35.1</b>
National Grasslands and Land Utilization Projects <sup>e/</sup>	6.2	0.5	0.1	0.5

a/ As reported by agencies.

b/ Deemed irrigable with water physically and legally  
available.

c/ Deemed irrigable but water not now physically or  
legally available.

d/ Indicates less than 50,000 acres.

e/ National Grasslands and Land Utilization Projects  
are administered by the Bureau of Land Management and the  
Forest Service. These acres are included in their figures.

Source: (6).

Table 6.--Estimated Acres of Land Suitable for Farming as Reported by Seven  
Federal Agencies in 17 Western States, 1968

State	Federal Land Owned <sup>a/</sup>	Federal Land Reported <sup>b/</sup>	Dryland	Irrigable (Water Available)	Irrigable (Water Not Available)
	(Millions of Acres)				
Arizona	32.4	33.0	0	11	7,145
California	44.4	44.7	172	137	6,129
Colorado	24.0	23.0	103	88	298
Idaho	34.0	31.6	85	314	2,623
Kansas	0.6	0.6	99	43	0
Montana	27.6	26.9	279	6	13
Nebraska	0.7	0.6	10	5	26
Nevada	61.0	60.6	4	7	9,916
New Mexico	26.7	26.1	0	11	2,922
North Dakota	2.1	2.2	262	4	4
Oklahoma	1.4	1.2	44	3	45
Oregon	32.2	29.6	67	72	625
South Dakota	3.4	3.3	237	46	97
Texas	3.0	2.3	149	6	190
Utah	35.2	35.2	1	14	2,557
Washington	12.6	13.8	15	158	42
Wyoming	30.0	30.7	469	387	2,437
<b>Totals</b>	<b>371.3</b>	<b>365.4</b>	<b>1,996</b>	<b>1,313</b>	<b>35,068</b>

a/ From Public Land Statistics 1967 (1), Table 7.

b/ Reported by seven Federal agencies surveyed in 1968, as identified in  
Table 5.

Source: (6).



Table 7.--Numbers of Intensive Agricultural Permits with Total Acreages and Rentals for All Agencies, by States, for a Hypothetical Year during the Period 1957-1968

17 Western States	Number Permits	Acreage	Annual Rent
Arizona	101	6,091	\$ 15,795
California	449	58,871	1,557,858
Colorado	72	5,815	32,384
Idaho	58	2,839	21,649
Kansas	708	111,754	397,474
Montana	157	12,733	37,132
Nebraska	136	27,184	404,909
North Dakota	579	60,288	152,957
New Mexico	31	2,337	15,984
Nevada	14	8,241	5,859
Oklahoma	580	128,885	248,198
Oregon	67	8,655	77,732
South Dakota	275	51,287	83,584
Texas	359	91,166	147,800
Utah	25	1,837	3,855
Washington	48	3,949	37,649
Wyoming	67	14,748	26,839
Total	3,726	596,680	\$3,267,658

Source: (6).

#### Potential Future Demands on Federal Lands

The potential role of the Federal lands in meeting 1980 and 2000 food and fiber needs will depend upon: (1) the amount of suitable Federal and non-Federal lands available, (2) the need for these lands for production, and (3) the relative cost of developing these lands for use. There are 38.4 million acres of Federal lands in the West that are suitable for intensive agriculture under varying assumptions. Only a small portion of these can be considered available for future use. Over 90 percent of these lands are Class C lands, lands that would be productive only if irrigation water were available. According to the South Dakota study, the future need for and value of water for urban and industrial non-consumptive uses by the year 2000 make it almost certain that the limited supplies of available water will not be used for the relatively low value and highly consumptive use of irrigation of Class C lands.

The value of alternative uses will limit the availability of Class A and Class B lands. The South Dakota analysis of the potential role of Federal lands for intensive agriculture concluded that only those Class A and B lands managed by the Bureau of Land Management, Bureau of Reclamation, the Corps of Engineers, and the Forest Service and Bureau of Land Management National Grasslands Land Utilization areas will likely be available in the future. Higher economic, social or political value in alternative uses will prohibit intensive agriculture on arable lands administered by the Department of Defense, the Bureau of Sport Fisheries and Wildlife, the National Park Service, and the Forest Service.

Of the total 38.4 million acres, only 2.2 million are considered to be readily available. These Bureau of Land Management, Bureau of Reclamation, Corps of Engineers and Forest Service controlled lands consist of 1.2 million acres suited for dryland production and 1.0 million acres needing feasible irrigation. The location of Bureau of Reclamation, Bureau of Land Management and Corps of Engineers lands by state and agency are shown in Table 8. Assuming that all 2.2 million acres were brought into production in accord with current production patterns and yields, the estimated effect would be small. As documented in Table 9, the use of available Federal cropland would increase the amount of cropland harvested in the 17 Western States by only 2 percent. Dryland harvested cropland would increase by less than 1 percent, and irrigated land harvested by about 5 percent.



Table 8.--Federal Public Lands Suited for Crop Production Held by Three Federal Agencies in 17 Western States, 1968  
(Thousand Acres)

State	Bur. of Reclamation		Bur. of Land Mgt.		Corps of Engrs.		Total	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
Arizona	...	6	...	...	...	...	...	6
California	4	20	...	...	...	...	4	20
Colorado	2	13	101	72	...	...	103	86
Idaho	...	146	83	160	...	...	83	306
Kansas	2	...	...	...	24	...	26	...
Montana	12	5	88	...	5	...	105	5
Nebraska	1	1	...	...	...	...	1	1
Nevada	...	2	...	...	...	...	...	2
New Mexico	...	...	...	...	...	...	...	...
North Dakota	...	...	4	...	18	...	22	...
Oklahoma	...	...	1	...	1	...	3	...
Oregon	1	23	59	...	...	...	60	23
South Dakota	...	...	30	...	1	...	31	...
Texas	...	...	...	...	61	...	61	...
Utah	...	1	...	...	...	...	...	1
Washington	1	103	...	...	2	1	3	104
Wyoming	...	102	203	284	...	...	203	387
Total	23	423	569	516	113	1	705 <sup>a/</sup>	941 <sup>a/</sup>

a/ The 705,000 dryland and 941,000 irrigable total 1.6 million acres. If Forest Service L.U. lands are added, the total would be 2.2 million acres.

Source: Estimates provided by these three agencies, as summarized in (6).

Table 9.--Private Cropland Harvested in 1964 and Arable Federal Lands Held by Bureau of Land Management, Bureau of Reclamation and Corps of Engineers in 17 Western States, 1968

State	Private Cropland Harvested <sup>a/</sup>			Federal Arable Public Lands			
	Total	Dryland	Irrigated	Dryland	Irrigated	Dryland Increase	Irrigated Increase
	(Thousand Acres)					(Percent)	(Percent)
Arizona	1,025	20	1,005	0.0	6.0	...	c/
California	7,846	1,409	6,437	4.1	20.3	c/	c/
Colorado	4,726	2,682	2,044	103.4	85.9	4	3
Idaho	3,935	1,696	2,239	83.0	306.3	5	14
Kansas	18,160	17,312	848	26.2	...	c/	...
Montana	7,813	6,433	1,380	104.9	5.2	2	c/
Nebraska	15,229	13,167	2,062	0.7	1.0	c/	c/
Nevada	507	4	503	...	2.5	...	1
New Mexico	906	218	688	...	...	...	...
North Dakota	17,695	17,646	49	22.3	...	c/	...
Oklahoma	8,344	8,084	260	2.5	...	c/	...
Oregon	3,050	1,964	1,086	59.6	22.5	3	2
South Dakota	14,445	13,310	1,135	31.0	...	c/	...
Texas	19,408	13,509	5,899	61.0	...	c/	...
Utah	1,039	270	769	...	1.1	...	c/
Washington	4,423	3,514	909	3.3	103.8	c/	11
Wyoming	1,702	598	1,104	203.1	386.6	34	35
Total	130,243	101,836	28,444	705.2 <sup>a/</sup>	941.2 <sup>a/</sup>	1	3

a/ The 705,000 dryland and 941,000 irrigable total 1.6 million acres. If Forest Service L.U. lands are added, the total would be 2.2 million acres.

b/ Water available.

c/ Less than 0.5 percent.

Source: (6).



The study of "Federal Public Land Laws and Policies Relating to Intensive Agriculture" concludes that suitable and potentially available Federal lands will not be needed to meet 1980 or 2000 food and fiber needs. This conclusion is based on the relatively small impact the use of these lands would have and the assumption that it will be in the public interest to meet future food and fiber needs at least costs.

According to the report, the average costs of developing arable Western public lands for production would be substantially higher than the costs of developing private lands either in the West or the East.<sup>5/</sup> On the basis of this argument, the claim was made that it would not be in the public interest to rely upon the public sector of the economy for needed agricultural lands, if such needs exist.<sup>6/</sup>

#### Land Used for Forage

The next four sections of this chapter are concerned with the past and future use of forage as livestock feed, with emphasis on the use of public lands for forage production. Forage, as used in this report, is defined as livestock feed obtained from animal grazing of pasture or open range.

#### Trends in National Forage Consumption

Forage is only one of the three principal livestock feeds. Feeds are generally classified as concentrates or roughage. Concentrates include grains, seeds, and by-product feeds. Roughage includes hay, silage, bulk feeds with low nutrient content, pasture, and forage. Concentrates are fed to all types of livestock. Swine and poultry are fed almost entirely from concentrates, although they may consume limited amounts of roughage. Only ruminants--cattle, goats and sheep--can be maintained entirely upon roughage.

<sup>5/</sup>The Bureau of Reclamation has estimated the average cost of future Federal irrigation projects at \$921, a "productive equivalent" acre or about \$600 per physical acre.

This compares with an average cost of \$313 per acre for non-Federal reclamation projects, and a maximum of \$200 an acre for clearing and draining of the millions of acres of lands suitable for agriculture in humid areas of the United States.

<sup>6/</sup>This conclusion assumes that minimum cost is the only or major objective of public policy. If other goals of public policy, such as the economic development of the West, are more important than economic efficiency, this conclusion is inappropriate.

Roughage may be mechanically harvested and fed to livestock or obtained from grazing of pasture or open range. In terms of feeding units<sup>7/</sup>, concentrates are the most important source of feed in the United States. In 1966, concentrates accounted for 46 percent, harvested forage 18 percent, and pasture and range 34 percent, of total livestock feed consumption. Comparable percentages for 1950 are 45, 19, and 35 percent, indicating the relative stability of trends in feed type through time (9).

#### Forage-Consuming Animals in the United States

The number of forage-consuming cattle in the United States has increased from 35.2 million in 1950 to 66.3 million in 1966. The number of stock sheep and lambs has declined, dropping from 26.2 million in 1950 to 21.5 million in 1966.

Regional changes in grazing populations during the 1950 to 1966 period are shown in Table 10. In 1950, the 11 Western States contained 37 percent of forage-consuming cattle and 44 percent of the sheep and lambs in the United States. Western populations in 1966 represent 21 percent of the estimated national grazing cattle and 46 percent of the stock sheep and lamb.

The national grazing cattle population has increased at an average compound rate of 4.1 percent since 1950. In the West, the rate of increase has been only 2.3 percent per year. Total stock sheep and lamb populations have decreased at the rate of 1.2 percent per year. The western sheep and lamb population has decreased at the somewhat slower rate of 1.0 percent, explaining the increasing relative importance of the sheep and lamb population in the West.

#### Forage Consumption by Grazing Animals

The standard measure of forage consumption by grazing animals is the animal unit month (AUM). One AUM is the amount of forage or feed required by one animal unit for one month. An animal unit is equivalent to one cow or five sheep or goats, all over six months of age. An AUM of forage equivalent is the amount of forage or feed required by one cow or five sheep or goats, all over six months of age, for one month.

<sup>7/</sup>One feed unit is the equivalent in feeding value of a pound (or ton) of corn.



Table 10.--Number of Forage-Consuming Cattle and Stock  
Sheep and Lambs, by Region, 1947-1966  
(Million Animals)

	1947 <sup>a/</sup>	1950	1955	1960	1966
<u>Grazing Cattle</u>					
11 Western States <sup>b/</sup>	8.8	9.4	11.9	11.1	13.6
Other States	22.4	25.8	37.2	47.7	52.7
United States	31.2	35.2	49.1	52.8	66.3
<u>Sheep and Lambs</u>					
11 Western States <sup>b/</sup>	11.9	11.5	12.1	12.6	9.8
Other States <sup>c/</sup>	15.2	14.7	15.1	16.3	11.7
United States <sup>c/</sup>	27.1	26.2	27.1	28.8	21.5

<sup>a/</sup> 1947 data estimated by extrapolation of 1950 to 1966 trends.

<sup>b/</sup> Includes Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

<sup>c/</sup> Excludes Alaska.

Source: Data compiled by the Public Land Law Review Commission.

In the remaining sections of this chapter, references to AUM's of forage consumption should be interpreted as meaning AUM's of forage equivalent. The procedure used to derive estimates of AUM's of forage consumption does not allow for a breakdown of AUM's into AUM's obtained from foraging of grazing land and AUM's obtained from concentrates or mechanically harvested roughage<sup>8/</sup>.

In 1966, the 11 Western States accounted for 22 percent of the total AUM's of forage equivalents consumed by foraging livestock in the United States. Some 187.2 million AUM's of forage equivalents were consumed by western livestock. Eighty-seven percent (163.6 million) was by cattle, and 13 percent (23.5 million) by sheep and lambs. In 1950, 29 percent of total AUM's consumed by sheep and lambs were accounted for by the West. The ratio of AUM's of sheep consumption to cattle consumption in the West was 1 to 7.0 in 1966, up considerably from the 1950 ratio of 1 to 4.1.

#### Potential Forage Consumption, 1980 and 2000

The ultimate purpose of reviewing projections of livestock forage consumption is to provide a benchmark from which the potential future demand for forage produced on public lands can be determined. Given this purpose, the ideal item to project is animal units of forage-consuming cattle and stock sheep and lambs. Such a projection is not available although Nathan Associates (5) has made projections of all roughage-consuming animal units<sup>9/</sup> and associated feed requirements. Nathan's projections are indicative of the future forage requirements of grazing cattle and stock sheep.

According to Nathan's medium-level projections, the total number of roughage-consuming animal units in the United States will increase from 103.5 million in 1965 to 135.1 million in 1980 and 191.2 million in 2000. Corresponding

<sup>8/</sup> Estimates of AUM's of consumption were obtained from The Forage Resource (11). AUM equivalent consumption by cattle were determined by multiplying estimated numbers of grazing livestock by 12. Consumption by sheep and lambs were determined by converting USDA estimates of sheep and lambs on farms on January 1 to animal units and multiplying the animal unit numbers by 12.

<sup>9/</sup> Includes poultry, horses, cattle, and sheep.



levels of corn equivalent feed expected to be obtained from pasture, grazing of harvested fields of field crops and other grazing are 194.01 million tons in 1980 and 314.53 million tons in 2000. The 1965 level was 132.4 million tons.

A comparison of the projected growth rates of foraging animal units and of feed consumption from pasture and grazing indicates that grazing will become an increasingly important source of feed. The absolute projection of roughage-consuming animal units represents a compound rate of growth of 1.8 percent per year. Projections of feed units from foraging represent a growth rate of 2.5 percent per year.

The implications of Nathan's projections of animal units and forage feed for the future forage requirements of grazing cattle and stock sheep and lambs are not obvious. In 1965, grazing cattle and stock sheep totaled 70.1 million animal units, 68 percent of the total 103.5 animal units reported by Nathan. The projected annual increase in total animal units was 1.8 percent. What portion of the projected animal units will be accounted for by cattle and sheep is not known. Nevertheless, it is possible to use Nathan's data as an indicative measure. Applying the projected growth rates for roughage-consuming animal units (1.8 percent) and forage consumption (2.5 percent) to 1966 forage consumption data under an "all other things equal" assumption, future high and low estimates of AUM requirements for grazing cattle and sheep are as follows:

Region	1966	Low Estimate (1.8%)		High Estimate (2.5%)	
		1980	2000	1980	2000
(Million AUM's)					
11 Western States	187.1	244.6	343.3	264.5	433.3
Other States	660.0	862.5	1,210.4	932.5	1,528.1
United States	847.1	1,107.1	1,553.7	1,197.0	1,961.4

#### Forage Supplied by Federal Lands<sup>10/</sup>

Seven Federal agencies have jurisdiction over acres of public lands that provide forage for domestic livestock (Table 11). About 96 percent of these lands are in the 11 Western States. In terms of total land area, 48 percent of

<sup>10/</sup>Data contained in this and the following section were obtained from the University of Idaho-Pacific Consultants, Inc., study, The Forage Resource (11).

Table 11.--Public Land Grazed in Western States, 1967

State	Acreage of Public Land <sup>a/</sup>	State Land Area in Public Ownership (Percent)	Public Land Allocated for Grazing <sup>b/</sup>	
			Million Acres	% of Total Public Land
Montana	27.6	29.6	16.5	59.9
Idaho	34.0	64.3	23.9	70.4
Wyoming	30.0	48.1	25.0	83.4
Colorado	24.0	36.2	20.5	85.2
New Mexico	26.7	34.4	22.3	83.5
Arizona	32.5	44.6	25.4	78.4
Utah	35.2	66.8	29.6	84.1
Nevada	61.0	86.8	48.7	79.9
Washington	12.6	29.4	5.1	40.7
Oregon	32.2	52.2	24.1	74.9
California	44.4	44.3	21.2	47.7
11 Western States	360.1	47.8	262.5	72.9
Other States	404.6	26.6	11.1	27.5
United States	764.8	33.7	273.6	35.7

<sup>a/</sup> Includes all Federally owned lands.

<sup>b/</sup> Data include National Grasslands and Land Utilization Projects.

Source: (11).



the 11 Western States are Federally owned, and 73 percent of this ownership is used for livestock grazing during some part of the year<sup>11/</sup>. Forage grass is the only or major crop of commercial value produced on a large portion of these lands.

The extent of the grazing land administered by each of the seven Federal agencies is shown in Table 12. Two agencies, the Forest Service and the Bureau of Land Management, administer 96 percent of all public lands grazed. Forage production is an important land management objective in both of these agencies. The other agencies listed in Table 12 permit grazing only when this land use does not interfere with their primary objectives.

Since 1947, the public lands have become slightly less important as a source of forage for grazing livestock. In 1947, 3.8 million cattle and horses and 11.9 million sheep grazed the public lands. By 1966, cattle and horse numbers had increased to 5.4 million and the number of sheep declined to 9.2 million (Table 13). In terms of animal units, use has declined from 8.5 million in 1947 to 7.2 million in 1966.

A more meaningful indicator of the trend that has taken place is the change in permitted AUM's of forage available for livestock consumption (Table 14). In 1966, Federal lands provided 25.3 million AUM's of forage, down 2 percent from the 25.9 million supplied in 1947. Use by cattle and horses increased by 17 percent (from 17.4 million to 20.4 million), but was more than offset by a 42 percent decline in permitted use for sheep (from 8.5 million to 4.9 million).

The number of AUM's permitted by agency and the revenues obtained from paid use permits are shown in Table 15.

For the United States as a whole, public lands supply only a small percentage of the feed requirements of domestic livestock. In 1966, only 3 percent of the AUM's required to sustain the nation's population of grazing cattle and stock

<sup>11/</sup> The elevation of Western public grazing lands influences grazing use by season. Approximately 75 percent of the grazing lands administered by the Forest Service are located in mountainous areas and are grazed only during the summer. Bureau of Land Management grazing lands are primarily at low elevations and receive relatively little summer use, but heavy spring, fall, and winter use. Yearlong use is made of some Bureau of Land Management lands, particularly in the Southwest desert area.

Table 12.--Grazing Lands Administered by Federal Agencies, 1967

Agency	Total Area Administered	Administered Exclusive of Alaska <sup>a/</sup>	Area Grazed a/	Grazed Area as Percent of	
				Total Area Administered	Area Admin- istered Ex- clusive of Alaska
(Million Acres)				(Percent)	
Forest Service	186.5	165.7	105.4	56.6	63.6
National Park Service	22.9	16.0	1.4	5.9	8.5
Bureau of Land Management	480.0	175.0	157.3	32.8	89.9
Bur. Sport Fish- eries & Wildlife	27.1	8.5	2.4	8.9	28.3
Bureau of Reclamation	9.0	9.0	3.7	40.6	40.6
Bureau of Indian Affairs	4.9	0.9	0.8	15.4	87.3
Department of Defense	30.5	27.9	2.7	8.8	9.6
Atomic Energy Comm.	2.2	2.2	b/	10.1	10.1
Total	763.1	405.1	273.6	35.9	67.5

<sup>a/</sup> Data include National Grasslands and Land Utilization Projects.

<sup>b/</sup> Grazing administered by the Bureau of Land Management. This acreage is also included in Bureau of Land Management acreage grazed.

Source: (11).



Table 14.--Number of AUM's of Permitted Livestock Use on the Public Lands in 1947, the Change in Permitted Number of AUM's in 1966, and the Percent of Change by Agency and Kind of Animal<sup>a/</sup>

Agency	Number of Permitted AUM's in 1947			Net Change in Number of Permitted AUM's as of 1966			Percent Change of 1947 AUM's		
	C&H	S&G	Total	C&H	S&G	Total	C&H	S&G	Total
	(1,000 AUM's)			(1,000 AUM's)			(Percent)		
Forest Service	7,917	2,467	10,384	-714	-1,189	-1,903	-9	-48	-18
National Park Service	63	17	80	19	-1	18	30	-6	22
Bureau of Land Management	8,620	5,800	14,420	2,416	-2,451	-35	28	-42	b/
Bur. Sport Fisheries & Wildlife	311	15	326	265	-2	263	85	-13	81
Bureau of Reclamation	321	205	526	-37	-29	-66	-12	-14	-12
Bureau of Indian Affairs	101	2	103	87	26	113	86	1,300	110
Department of Defense	40	28	68	960	20	980	2,400	71	1,441
Total U.S.	17,375	8,534	25,909	2,996	-3,626	-630	17	-42	-2
11 Western States	16,342	8,494	24,836	1,481	-3,637	-2,156	9	-43	-9

<sup>a/</sup> AUM numbers include use and non-use. Cattle and horse are abbreviated as C&H, sheep and goats as S&G.

<sup>b/</sup> A decrease of 0.2 percent.

Source: Compiled from information supplied to the Public Land Law Review Commission by the various agencies, as reported in (11).

Table 13.--Number of Animals Permitted on the Public Lands in 1947, the Change in Number Permitted in 1966, and the Percent of Change by Agency and Kind of Animal<sup>a/</sup>

Agency	No. Animals, 1947			Net Change in Number of Animals as of 1966			Percent Change of 1947 Animals		
	C&H	S&G	Total	C&H	S&G	Total	C&H	S&G	Total
	(1,000 Animals)			(1,000 Animals)			(Percent)		
Forest Service	1,427	4,063	5,491	46	-1,751	-1,705	3	-43	-31
National Park Service	22	35	57	-2	-1	-3	-9	-3	-5
Bureau of Land Management	2,215	7,526	9,741	1,236	-961	275	56	-13	3
Bur. Sport Fisheries & Wildlife	60	16	76	81	8	89	135	50	117
Bureau of Reclamation	80	253	333	19	0	19	24	0	6
Bureau of Indian Affairs	8	2	11	12	10	22	150	500	200
Department of Defense	12	36	49	136	1	137	1,133	3	280
Total U.S.	3,824	11,931	15,758	1,528	-2,695	-1,167	40	-23	-7
11 Western States	3,687	11,918	15,605	1,265	-2,712	-1,447	34	-23	-9

<sup>a/</sup> Numbers include use and non-use. Cattle and horses are abbreviated as C&H, sheep and goats as S&G.

Source: Compiled from information supplied to the Public Land Law Review Commission by the various agencies, as reported in (11).



Table 15.--AUM's of Domestic Livestock Permitted and Grazing Receipts, by Agency, 1947-1966  
(Million AUM's and Million Dollars)

Fiscal Year	National Forests		National Park Service		Bureau of Land Management		Bureau of Sport Fish & Wildlife		Bureau of Reclamation	
	AUM	Rec'ts	AUM	Rec'ts	AUM	Rec'ts	AUM	Rec'ts	AUM	Rec'ts
					a/	b/				
1947	8.1	2.3	e/	...	15.0	1.1	...	...	.52	...
1948	...	2.9	...	...	14.7	1.5	...	...	...	...
1949	7.6	3.3	...	...	14.5	1.2	...	...	...	...
1950	...	3.4	...	...	14.5	1.4	.3	.2	...	.1
1951	7.3	4.2	...	...	14.3	1.6	.3	.3	...	.1
1952	7.3	5.0	...	...	15.4	2.0 <sup>c/</sup>	.3	.3	...	.1
1953	7.4	4.4	...	...	15.8	2.0	.4	.4	...	.1
1954	7.3	3.1	...	...	15.7	1.9	.4	.4	...	.1
1955	7.2	3.0	.1	.02	15.4	2.1	.4	.4	...	.1
1956	7.1	2.9	.1	.02	15.3	2.3	.4	.4	...	.1
1957	6.4	2.7	.1	.02	14.7	2.1	.4	.4	...	.1
1958	6.8	3.0	.1	.02	14.8	2.6	.4	.4	...	.1
1959	6.8	3.8	.1	.02	14.8	3.1	.7	.4	...	.1
1960	6.8	3.6	.1	.02	12.7	3.4	.4	.4	...	.1
1961	6.6	3.3	.1	.02	12.4	2.9	.4	.5	...	.1
1962	6.6	3.2	.1	.02	15.0	2.7	.4	.4	.50	.1
1963	6.5	3.4	.1	.02	15.0	3.9	.5	.5	.50	.1
1964	6.4	3.2	.1	.02	14.8	4.3	.5	.6	.50	.1
1965	6.5	3.0	.1	.02	14.8	4.1	.4	.6	.51	.1
1966	6.6	3.3	.1	.04	14.7	4.7	.5	.7	.46	.1
1967	6.6	3.6	.1	.04	14.5	4.6	.5	.8	...	.1
1968	6.6	3.5	.1	.04	14.3	4.6	.5	.8	...	.1

a/ Excludes grazing on land utilization projects where not part of grazing districts, and Alaskan grazing. As of 1960, data reported on a calendar-year basis. Includes non-use and exchange of use permits.

b/ Includes Taylor Act grazing, grazing in Alaska, and land utilization projects.

c/ Includes receipts from reclamation lands.

d/ AUM data not available.

e/ Indicates data not available.

Sources: (2) and unpublished records supplied by the Department of Interior.

sheep was represented by the AUM's permitted on public lands<sup>12/</sup>. For grazing cattle, the percentage was 2.6, for sheep 9.5. These figures represent a 50 percent decrease in the relative importance of Federal forage since 1947. Comparable figures for 1947 were 6 percent of the AUM's required by all grazing domestic livestock, 5 percent for cattle, and 13 percent for sheep.

The declining importance of Federal forage is also evident in the 11 Western States. In 1947, 19 percent of the AUM requirements for all domestic western livestock, 16 percent of the requirements for western cattle, and 30 percent of the requirements for western stock sheep were permitted on Federal lands. In 1966, 12 percent of total western forage requirements were supplied by public lands. Permitted use on Federal lands represented 11 percent of the feed required by western cattle and 20 percent of feed required by western sheep. The public lands contribution to 1966 livestock forage requirements is shown by state in Table 16.

#### Demand for Forage Production on Federal Lands, 1980 and 2000

In the previous section, it has been noted that the Federal lands in the United States are becoming less important as a source of forage for grazing livestock. Although the permitted number of AUM's of grazing declined by only 2 percent between 1947 and 1966, the relative importance of Federal forage to the national livestock industry has declined by 50 percent.

If the trends established during the last two decades continue, the AUM's of forage supplied from public lands will become even less significant, given projections of future AUM requirements. This will be true even if one assumes that the number of AUM's permitted on Federal lands will remain constant at the 1966 level of 25.3 million AUM's rather than decline. Using the projection of total AUM requirements presented earlier, 1966 AUM's of forage production

<sup>12/</sup> This is an approximation. The number of AUM's permitted for cattle on public lands is reported in combination with AUM's permitted for horses. In 1966, public agency forage allocations for pack and riding stock used incidental to recreational use totaled 90,859 AUM's, 0.04 percent of the AUM's consumed by all cattle and horses on Federal grazing lands.



Table 16.--Grazing Potential of the Public Lands with Intensive Range Improvement Practices (1,000 AUM's)

Agency	AUM's Supplied in 1966	AUM's Possible with Improvement <sup>a/</sup>	Difference	Percentage Increase
Forest Service	7,989	14,598	6,609	83
Bureau of Land Management	13,275	21,400	10,748	61
National Park Service	35	62	27	77
Bur. Sport Fisheries & Wildlife	582	994	412	71
Bureau of Reclamation	458	762	304	66
Bureau of Indian Affairs	216	269	53	24
Department of Defense	79	93	14	17
Total	22,634	38,178	18,167	69

<sup>a/</sup> Forest Service and Bureau of Land Management data supplied by these agencies. Other estimates from University of Idaho and Pacific Consultants, Inc., The Forage Resource, Moscow, Idaho, Table III A-8.

Source: (11).

on Federal land will represent the following percentages of total AUM requirements in 1980 and 2000:

Percent of Forage Requirements to Be Supplied From Public Lands in 1980 and 2000 under Two Assumptions about the Growth Rate of Total Forage Requirements

Region	Current Supply (1966)	Nat'l. Requirements		Increasing at	
		1.8% per year <sup>a/</sup>	2.5% per year <sup>b/</sup>	1980	2000
11 Western States	12.1	9.3	6.6	8.6	5.2
Other States	.4	.3	.2	.3	.2
United States	3.0	2.3	1.6	2.1	1.3

<sup>a/</sup> Projected growth rate of forage-consuming animals.

<sup>b/</sup> Projected growth rate of forage consumption by forage-consuming animals.

Under either the high or the low assumptions about future national requirements, public forage AUM's available in 1966 will represent less than 2 percent of total national requirements by 2000.

Under the appropriate political and economic conditions, the public grazing lands could produce substantially more AUM's than they have in the past. Estimates of potential production are compared with current production in Table 16. Potentially, grazing capacity could be increased by 69 percent to 38.1 million AUM's through range improvement known to be technically possible at this time<sup>13/</sup>. The potential increases on land administered by the Forest Service and the Bureau of Land Management account for 95 percent of the possible increases.

The likelihood of actual realization of the potentials shown in Table 16 is small. Only the Forest Service and the Bureau of Land Management view forage production as a high-priority land management objective. Both of these agencies manage their lands for multiple products, including timber, water, livestock forage, wildlife, recreation and minerals.

<sup>13/</sup> The costs of producing the potential level through range improvement are not known.



Since 1947 nearly 33 million acres of former grazing land have been closed to grazing in favor of watershed protection (3.9 million), wildlife use (4.8 million), and recreational uses (24.0 million), primarily natural and wilderness areas (22.7 million). An additional 1 million acres was lost to grazing through sales or grants to private parties (11). Continued pressure on grazing lands for the exclusive use of recreation, wildlife, and water could easily offset increases in AUM production that are possible through range improvement.

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## CHAPTER III

### FISH AND WILDLIFE RESOURCES

The principal role of the Federal lands in the area of fish and wildlife is one of providing wildlife habitat<sup>1/</sup>. By developing and protecting the natural environment needed to sustain fish and wildlife, Federal land managing agencies provide a service to two broad and often overlapping classes of clientele--the consumptive users and the appreciative users. The consumptive user group is composed mainly of sport fishermen and hunters. Appreciative users include the nation's 8 million bird watchers, 3 million wildlife photographers (4), and an unknown number of those concerned with the welfare of fish and game simply because these animals are part of the natural environment.

The review of the role of Federal lands as wildlife habitat given below is based almost entirely upon data contained in the report to the Public Land Law Review Commission on Fish and Wildlife Resources on the Public Lands, prepared by the Department of Fishery and Wildlife Biology, Colorado State University (1). Data are presented for the 20 states shown in Figure 1<sup>2/</sup>. Each of these states contains significant areas of Federally managed wildlife habitat. In total, the 20 states considered contain 94 percent of the Federal land in the conterminous states.

#### Current Role of the Federal Lands

##### Habitat Management by Federal Agencies

Ten Federal agencies manage lands in one or more of the 20 states shown in Figure 1. Only five are authorized by Congress to manage fish and wildlife habitat: the Bureau

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<sup>1/</sup> Fish and game population management is normally the responsibility of state fish and game agencies.

<sup>2/</sup> Reliable data describing habitat, wildlife population number, and harvest in the entire United States are not available.





FIGURE 1.-- THE TWENTY SELECTED STATES AND REGIONAL DESIGNATION



of Sport Fisheries and Wildlife, Bureau of Land Management, National Park Service, Forest Service, and Department of Defense.

The Bureau of Sport Fisheries and Wildlife is the only agency that has as its principal function the administration of fish and wildlife programs. Responsibilities of the Bureau include the national migratory bird program, National Refuge System, National Fish Hatchery Systems, management of fish and wildlife programs on lands under the jurisdiction of a number of other Federal agencies, the Endangered Species Program, and assistance in predator and rodent control. The Bureau of Land Management and Forest Service are required by multiple use legislation and administrative regulations to develop their lands for fish and wildlife. The National Park Service manages wildlife, by law, for the enjoyment of future generations. The Department of Defense has the authority to manage wildlife resources on its lands in cooperation with the Bureau of Sport Fisheries and Wildlife.

The five agencies not authorized to manage fish and game habitat on the lands they administer are the Bureau of Indian Affairs, Bureau of Reclamation, Corps of Engineers, Federal Power Commission, and Atomic Energy Commission. Except for the Atomic Energy Commission, each of these agencies undertake habitat management through cooperation or consultation with the Bureau of Sport Fisheries and Wildlife or state game and fish agencies. The Atomic Energy Commission does not manage their lands for wildlife or fish.

With the notable exception of the Bureau of Sport Fisheries and Wildlife, production of wildlife on Federal lands is usually a byproduct of other land management activities. For the most part, management is aimed at maintaining wildlife-sustaining environment that could be damaged or destroyed as a result of other land management activities. This is true even for the Forest Service and Bureau of Land Management, the multiple-use agencies. Forest Service and Bureau of Land Management wildlife management consists mainly of maintaining habitat by insuring that agency lands are not overgrazed, that roads are not built up and down stream beds, that solid blocks of land are not planted with one species of tree, and other similar preventive practices.

Management activities initiated specifically to improve wildlife habitat (as opposed to habitat maintenance) have been conducted primarily by the Forest Service, Bureau of Land Management, and Bureau of Sport Fisheries and Wildlife. As shown by Table 1, the Forest Service has been the most active. More than \$2.5 million per year during the 1962-

TABLE 1.--Fish and Wildlife Habitat Improvement Practices in the 48 States, Average Annual Amounts, 1963-1967

Habitat Improvement Practice	U.S. Forest Service		Bureau of Land Management			Bureau of Sport Fisheries and Wildlife a/b/	
	Amount	Cost c/	% of State Funds d/	Amount	Cost	Amount	Cost
Seeding and Planting (Acres)	30,557	\$599,786	41	22,931	\$164,463	9,290	\$113,974
Release Spraying and Cabling (Acres)	16,777	325,241	33	4,464	24,789	24,625	407,707
Prescribed Burning (Acres)	42,324	50,450	43	-	-	44,189	44,189
Protection Fencing (Rods)	13,848	58,238	11	15,381	61,264	90,660	280,363
Permanent Wildlife Openings (Acres)	6,793	265,079	57	-	-	1,600	21,776
Water Development (Number)	1,015	138,290	41	142	113,737	333	171,575
Waterfowl Marsh Improvement (Number)	1,469	60,087	39	52	8,442	54,685	114,572
Stream Channel Improvement (Number)	1,876	167,249	21	9	3,258	-	-
Spawn Bed Improvement (Rods)	691	13,177	20	-	-	-	-
Barrier Removal d/ (Number)	1,469	335,026	38	59	5,709	-	-
Channel Stabilization and Fencing (Rods)	18,442	51,626	24	271	3,822	12,839	184,700
Aquatic Plant Control (Acres)	1,281	13,196	64	-	-	3,199	21,089
New Fishing Lakes (Acres)	1,091	480,278	75	-	-	-	-
Spawn Beds and Shelters (Number)	387	15,688	48	-	-	-	-
Wildlife Tree and Shrub Planting	-	-	-	-	-	318	15,746
Total Average Annual Cost		\$2,473,411			\$385,484		\$1,375,691

a/ The Bureau of Sport Fisheries and Wildlife did not have cost sharing programs.

b/ Averages based on four-year period, 1964-1967.

c/ Averages based on three-year period, 1965-1967.

d/ Percent of funds supplied by states.



1967 period was spent by the Forest Service in cooperation with the states on habitat improvement. Of the total \$4.2 million average 1962-1967 expenditure on habitat improvement by these agencies, Forest Service activities accounted for 58 percent, Bureau of Land Management 9 percent, and Bureau of Sport Fisheries and Wildlife 33 percent. By type of habitat improvement practice, \$3.0 million was spent for game habitat improvement, and \$1.33 million for fisheries habitat improvement.

Federal lands that are designated primarily for the protection, production or feeding of wildlife total 12.5 million acres. The Bureau of Sport Fisheries and Wildlife administers 80 percent of this area for migratory bird and waterfowl refuges (4.8 million acres), and game refuges and sanctuaries (5.2 million acres). The Forest Service manages 1.4 million acres of refuges and sanctuaries, and the Bureau of Land Management has set aside 1.2 million acres for the benefit of wildlife. The regional distribution of these reserved areas is given in Table 2.

#### Game Population, Habitat, and Harvest

The percentage of state game populations residing on Federal lands in each of the 20 states is given in Table 3. Federal lands within these states, comprising 37 percent of the land area, provide habitation for 48 percent of the big game animal population during the summer, and 40 percent during the winter. Lands administered by the Forest Service, Bureau of Land Management and National Park Service account for 98 percent of the summer and 95 percent of the winter big game populations on Federal lands (Table 4). These percentages are in accord with the number of acres of lands providing big game habitat managed by these agencies. In the 20 states considered, 90 percent of all Federal lands and 95 percent of the Federal lands providing big game habitat are managed by these three agencies (Table 5). The regional distribution of big game population on all Federal lands in the 20 states is shown in Table 6.

Estimates of state populations of waterfowl, upland birds, small game and furbearers are not available. The estimates of the percentage of these animals occurring on Federal lands given in Table 2 were made by state fish and game agencies. These estimates are not addable, but they do indicate some general trends. Waterfowl and upland game birds inhabiting woodlands and prairies are relatively abundant on Forest Service and Bureau of Land Management



TABLE 2.—Federal Areas Acquired or Designated Primarily for Wildlife, by Region, 1967<sup>a/</sup>

Region	Migratory Waterfowl Refuges		Waterfowl Production Areas		Migratory Bird Refuges		Big Game Refuges		Game Ranges		Wildlife Ranges		Coordination Areas		Fish Hatcheries		BLM Lands Withdrawn for Wildlife		Forest Service Refuges and Sanctuaries		Totals	
	No. <sup>b/</sup>	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No. <sup>d/</sup>	Acres	No.	Acres	No. <sup>e/</sup>	Acres
New England	6	36,956	1	116	-	-	-	-	-	-	-	-	-	-	5	974	-	-	-	-	11	38,046
Mid Atlantic	8	46,645	-	-	-	-	-	-	-	-	-	-	1	87	2	297	-	-	-	-	11	47,029
East North Central	15	346,275	-	-	5	392	-	-	-	-	-	-	2	86,144	9	2,281	-	-	1 <sup>c/</sup>	4,010	32	439,102
West North Central	83	769,121	8,493	677,221	2	28	2	20,796	-	-	-	-	14	114,008	14	2,405	-	4,000	2	50,414	117	1,637,993
South Atlantic	31	687,410	-	-	13	346,661	1	6,745	-	-	-	-	2	51,894	21	3,072	-	-	5	283,643	73	1,379,425
East South Central	14	253,239	-	-	-	-	-	-	-	-	-	-	-	-	8	1,255	-	-	1	10,900	23	265,394
West South Central	18	554,530	-	-	4	11,758	1	59,020	-	-	-	-	-	-	10	824	-	-	5	219,973	38	846,105
Mountain	45	585,427	-	-	1	248	4	157,045	4	2,416,283	1	1,588,374	26	295,294	18	4,585	-	166,562	2	782,918	101	5,996,741
West Coast	30	496,667	-	-	11	2,648	2	282,429	-	-	-	-	14	25,433	11	2,483	-	988,313	2 <sup>c/</sup>	68,770	70	1,866,743
All Regions	250	3,776,270	8,494	677,337	36	361,735	10	526,035	4	2,416,283	1	1,588,374	59	572,860	98	18,176	-	1,158,875	18	1,420,628	476	12,516,578

<sup>a/</sup> Data supplied by the Bureau of Sport Fisheries and Wildlife, Bureau of Land Management, and the Forest Service. Data do not include administrative sites and research centers.

<sup>b/</sup> Areas bordering two or more states are listed in only one of the states.

<sup>c/</sup> One area in California and one in Michigan established for endangered species (i.e. Condors and Kirtland's Warbler).

<sup>d/</sup> Not applicable.

<sup>e/</sup> Number does not include Waterfowl Production Areas or BLM wildlife lands.



TABLE 3.--Percentage of State Game Populations Occurring on Federal Land  
in each of 20 Selected States a/

State	% of Land in Federal Ownership	Percentage of Game Populations Occurring on Federal Land <u>b/</u>								
		Big Game		Waterfowl			Upland Birds		Small Game	Fur- bearers
		Summer	Winter	Breeding	Migrating	Wintering	Non- Farm	Farm		
West Coast										
California	44	48	38	30	65	40	40	3	22	40
Oregon	52	61	43	53	50	36	62	25	45	37
Washington	29	43	21	10	20	19	45	4	5	15
Mountain										
Arizona	45	87	83	78	c/	73	40	0	53	74
Colorado	36	85	69	25	22	21	26	3	60	43
Idaho	64	90	69	Tr	c/	90	85	5	75	60
Montana	30	54	35	60	80	36	85	20	c/	75
Nevada	87	97	99	76	82	79	88	1	87	86
New Mexico	34	48	48	55	45	50	82	30	45	40
Utah	67	85	69	46	61	56	46	15	47	75
Wyoming	48	56	55	29	53	3	73	Tr	61	60
Eastern										
Arkansas	9	25	24	1	1	Tr	20	1	11	11
Florida	10	21	21	c/	c/	24	6	3	8	c/
Michigan	9	23	24	20	20	1	18	0	4	6
Minnesota	7	8	8	17	12	10	18	1	7	10
New Hampshire	12	7	7	2	2	0	5	0	10	1
North Carolina	6	7	7	Tr	21	16	4	2	3	5
South Dakota	7	43	42	12	60	90	12	2	2	10
Virginia	8	29	29	1	30	25	32	Tr	10	Tr
West Virginia	6	26	26	Tr	4	4	15	Tr	6	7
Averages <u>d/</u>	37	48	40	<u>e/</u>	<u>e/</u>	<u>e/</u>	<u>e/</u>	<u>e/</u>	<u>e/</u>	<u>e/</u>

a/ Data adapted from information supplied by the State Game and Fish agencies. Reported accuracy of the state estimates varied from less than 70% to over 95%.

b/ Tr indicates trace, or less than 1 percent.

c/ Information lacking or available in a form not adaptable to this use.

d/ Averages are weighted according to the number of acres or the number of animals in each state.

e/ Averages are not shown because population data necessary for proper weighting is not available.



TABLE 4.--Relative Use of Federal Agency Lands by Game Populations in 20 Selected States<sup>a/</sup>

Federal Agency	Percentage of Total Land Area	Percentage of Overall Game Populations Occurring on Federal Land <sup>b/</sup>									
		Big Game		Waterfowl			Upland Birds		c/ Small Game	Fur-bearers	
				c/ Breeding	d/ Migrating	Wintering	Non-Farm	Farm			
		Summer	Winter								
Forest Service . . . . .	14.9	34	19	8	2	1	21	1	9	17	
Bureau of Land Management . . . . .	17.0	11	17	3	2	2	14	2	16	10	
Bur. of Sport Fish & Wildlife . . . . .	0.6	Tr	Tr	8	16	17	2	Tr	1	2	
National Park Service . . . . .	1.4	2	1	1r	1	2	1	Tr	Tr	1	
Bureau of Reclamation . . . . .	0.9	Tr	Tr	4	10	7	Tr	Tr	Tr	2	
Bureau of Indian Affairs . . . . .	0.1	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	
Air Force . . . . .	0.8	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	
Army - Military . . . . .	0.6	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	
Corps of Engineers . . . . .	0.2	Tr	Tr	Tr	3	5	Tr	Tr	Tr	Tr	
Navy . . . . .	0.3	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	
Atomic Energy Commission . . . . .	0.2	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	
Total - All Federal Lands . . . . .	37.0	48	40	27	37	34	40	6	30	34	

<sup>a/</sup> Data adapted from information supplied by the game and fish agencies of the 20 states listed in Table 1. Reported accuracy of the state estimates varied from less than 70% to more than 95%.

<sup>b/</sup> Unweighted figures are used for waterfowl, upland birds, small game, and furbearers because population numbers were not available for each state.

Tr indicates trace, or less than 1%.

<sup>c/</sup> Represents usable data from only 19 of the 20 states.

<sup>d/</sup> Represents usable data from only 17 of the 20 states.

TABLE 5.--Big Game Habitat on Federal Land, by Agency, in 20 Selected States<sup>a/</sup>

Federal Agency	Total Area Administered (Acres in 1,000's)	Area Providing Big Game Habitat	
		Percent	(Acres in 1,000's)
Forest Service	154,120	96	147,870
Bureau of Land Management	175,696	78	137,222
Bureau of Sport Fisheries & Wildlife	6,534	88	5,721
National Park Service	14,404	92	13,240
Bureau of Reclamation	8,857	32	2,877
Bureau of Indian Affairs	794	38	298
Air Force	8,127	21	1,685
Army - Military	6,542	56	3,663
Army - Corps of Engineers	2,398	78	1,872
Navy	3,030	14	411
Atomic Energy Commission	1,856	42	779
Totals	382,358	83	315,638

<sup>a/</sup> Based on estimates by the state game and fish agencies of the percentage of the lands of each federal agency providing habitat for big game. Reported accuracy of the estimates varied from less than 70% to more than 95%. The 20 states are identified in Figure 1.



TABLE 6.---Big Game Populations on Federal and Non-Federal Lands, by Regions<sup>a/</sup>

Land Classification	Region <sup>b/</sup>						Combined 20 States Included in the 3 Regions
	West Coast		Mountain		Eastern		
	Summer	Winter	Summer	Winter	Summer	Winter	
Federal Lands:							
Forest Service . .	1,143,490	410,757	1,582,409	664,892	435,882	348,417	3,161,781
Bureau of Land Management . . .	260,684	378,372	743,379	919,056	6,291	6,351	1,010,354
Fish and Wildlife Service . . . . .	7,923	5,250	21,474	21,406	26,110	18,930	55,507
National Park Service . . . . .	63,921	16,551	99,293	40,794	26,066	21,810	189,280
Bureau of Reclamation . . . . .	2,776	2,331	16,605	23,022	3,400	3,115	22,781
Bureau of Indian Affairs . . . . .	0	0	826	696	720	500	1,546
Air Force . . . . .	2,135	1,582	4,749	7,510	26,042	25,717	32,926
Army - Military . .	6,855	5,270	13,701	15,120	8,159	6,109	28,715
Corps of Engineers . .	78	63	33,596	25,249	12,635	9,935	46,309
Navy . . . . .	4,210	3,178	846	615	9,525	7,825	14,581
Atomic Energy Commission . . . . .	2,375	2,000	428	438	0	0	2,803
All Federal Lands	1,494,447	825,354	2,517,306	1,718,798	554,830	448,709	4,566,583
Non-Federal Lands	1,340,283	1,427,796	1,020,067	1,101,609	2,496,415	1,956,201	4,856,765
All Lands . . . . .	2,834,730	2,253,150	3,537,373	2,820,407	3,051,245	2,404,910	9,423,348
							7,478,467

a/ Data adapted from information supplied by the respective state game and fish agencies. Reported accuracy of the information varied from less than 70% to over 95%.

b/ See Figure 2 on page 7 for map of states included in each region.

lands, particularly in the Mountain States. Upland game birds inhabiting farm land are relatively scarce on Federal lands, except in Oregon, Montana and New Mexico. Small game populations appear to be concentrated on Federal lands in the Mountain States, and to inhabit mostly non-Federal lands in the Eastern and West Coast States.

For big game, the distribution of game habitat between all Federal and all non-Federal lands is virtually equal to the distribution of game populations shown in Table 3. Although habitat inventories are not available for documentation, this relationship probably is also true for other classes of game.

Not all Federal lands are open to hunting by the public. An estimated 7 percent (28 million acres) of the Nation's Federal lands, mostly National Parks, Wildlife Refuges, and certain military installations, is closed to hunting. Another 3 percent is open only for certain species or open only to selected people because of security reasons. Moreover, not all of the remaining 90 percent or 353 million acres that are officially open to hunting are actually available to recreationists. Access to Federal lands is often restricted or even prohibited by adjacent private landowners. And, nearly 200 million acres of Federal land are considered to be inadequately identified as Federal property, thereby discouraging the full use of these lands.

In the 11 Western States, sportsmen are effectively excluded from 8.2 million acres of otherwise open public land by livestock fences constructed on adjacent private land. An additional 8.9 million acres are blocked in by private landowners who simply deny access to recreationists (6.2 million acres), or charge a fee as high as \$25 for the privilege of crossing private lands to reach Federal land (2.7 million acres)(1). Access problems are most prevalent on lands administered by the Bureau of Land Management under the Taylor Grazing Act and in national forests.

While still serious, the extent of the access problem has diminished over the last ten years. Between 1958 and 1967, \$8.3 million was spent by Federal agencies and \$3.8 million by state fish and game agencies to provide access to 5-1/4 million acres of previously blocked-in Federal land in the 11 Western States. Federal expenditures were \$7.6 million for the construction of access roads to locked-in areas and \$3.8 million for acquisition of private land; state expenditures were \$2.9 million for land and \$1.0 million for road construction.



The average annual harvest of game in the 48 states during the 1962-1966 period totaled 192 million animals. Eight percent of the harvest was on Federal lands. The breakdown by species is given below:

Game Species	Total Number Harvested	Harvested on Federal Lands	
	(Millions)	Number	Percent
Big game	2.2	0.8	35
Waterfowl	50.6	3.3	7
Upland game birds	56.1	4.5	8
Small game	75.4	6.1	8
Furbearers	8.2	.7	9
Total	192.5	15.4	8

The total and Federal harvest is given by geographic region in Table 7. In terms of total numbers, 55 percent of the game harvested on Federal lands is in the Mountain (23 percent) and the West Coast (32 percent) States.

For big game, the Federal lands contribute less to the annual harvest than is indicated by the percentage of population that resides on Federal lands. For the 20 states shown in Figure 1, 40 percent of the big game resides on Federal land, but only 35 percent of the harvest comes from these lands. Only on the West Coast does the contribution to harvest exceed the share of population on Federal lands. By region, population and harvest shares on the Federal lands in the 20 states are:

Region	Big Game	
	Population	Harvest
	(Percent)	
West Coast	53	58
Mountain	71	66
East	18	10

Similar data are not available for species other than big game, although it is possible to compare the relative harvest for some species on Federal and other lands in the 20 states on the basis of harvest per unit of land area:

TABLE 7 --Average Annual Harvest of All Game and Furbearers and the Contribution of Federal Lands, 1962-1966<sup>a/</sup>

Region	% of Land in Fed. Owner- ship	Total Number Harvested	Harvested on Federal Land	
			Number	%
New England <sup>b/</sup>	2.9	1,202,222	28,756	2
Mid Atlantic	1.4	6,379,973	59,346	1
East North Central	3.9	27,725,367	726,150	3
West North Central	3.7	28,983,715	1,565,876	5
South Atlantic <sup>c/</sup>	6.9	36,377,143	1,907,313	5
East South Central	4.6	24,451,481	783,834	3
West South Central	3.0	39,158,923	1,866,234	5
Mountain	49.5	9,504,247	3,562,246	37
West Coast	42.8	18,722,991	4,913,943	26
All States	21.3	192,506,059	15,413,698	8

<sup>a/</sup> Subject to exclusions of specific data as listed in footnotes to Appendix Tables 5-8 of (1).

<sup>b/</sup> Excluding Massachusetts.

<sup>c/</sup> Excluding South Carolina.



Harvest Per Unit Acre on Federal Lands	Small Game	Non-Farm Upland Birds	Furbearers
	(Number of states)		
Less than on other land	7	10	11
Equal to other lands	8	2	5
Greater than other lands	3	8	2

Two possible reasons for the relatively low harvest on Federal lands are difficulty of access and the fact that Federal lands generally tend to be located further from large population centers than other hunting lands.

#### Fish Habitat

In 1965, there were 81.6 million surface acres of inland sport fishing waters in the United States. The 20 states shown in Figure 1 contain 14.2 million acres, or slightly less than one-fifth of the total fish habitat. Roughly two-thirds of the surface water in the 20 states is warm water; one-third is cold water (capable of supporting salmonoids). The cold waters are primarily in the West and the warm waters in the East.

Federal ownership accounts for one-third of the 14.2 million acres; state and other public lands, 62 percent; and private owners, 5 percent. The ownership patterns by type of water and region are given in Table 8 and summarized below:

Ownership	Cold Water	Warm Water
	(Percent)	
Federal	55	23
Other public	43	71
Private	2	6
Total	100	100

Federal ownership accounts for 45 percent of fish habitat in the West Coast States, 71 percent in the Mountain States, and 15 percent in the Eastern States.

TABLE 8.--Acres of Fishing Waters by Type, Region, and Land Classification in 20 States<sup>a/</sup>

Land Classification and Type of Water	Region <sup>b/</sup>		
	West Coast	Mountain	Eastern
<b>Federal:</b>			
Cold Water Lakes . . . . .	762,655	1,345,505	29,781
Cold Water Streams . . . . .	198,516	176,598	12,875
Warm Water Lakes . . . . .	217,672	737,714	1,245,426
Warm Water Streams . . . . .	0	33,400	11,329
All Waters . . . . .	1,178,843	2,293,217	1,299,411
<b>Other Public:</b>			
Cold Water Lakes . . . . .	822,189	434,426	406,659
Cold Water Streams . . . . .	106,794	102,527	60,984
Warm Water Lakes . . . . .	318,113	238,218	5,042,978
Warm Water Streams . . . . .	125,235	37,900	1,189,441
All Waters . . . . .	1,372,331	813,071	6,700,062
<b>Private:</b>			
Cold Water Lakes ) <sup>c/</sup> . . . . .	12,800	74,394	7,738
Cold Water Streams ) <sup>c/</sup> . . . . .	49,000	50,674	428,451
Warm Water Lakes ) <sup>c/</sup> . . . . .			
Warm Water Streams ) <sup>c/</sup> . . . . .			
All Waters . . . . .	61,800	125,068	436,189
Grand Totals . . . . .	2,612,974	3,231,356	8,435,662

<sup>a/</sup> Adapted from data supplied by the U. S. Bureau of Sport Fisheries and Wildlife.

<sup>b/</sup> Regions as shown on map, Figure 1.

<sup>c/</sup> Separate data unavailable.



Available agency fish habitat inventories in the 20 states are given in Table 9. These data indicate that Forest Service lands provide extensive areas of fish habitat, Bureau of Land Management lands provide only limited amounts of fishing waters, and that Corps of Engineers and Bureau of Reclamation reservoirs account for a large and significant portion of the standing waters in the 20 states.

An estimated 95 percent of the fishing waters on Federal lands are open for fishing. The 5 percent closed to fishing includes 200,000 acres of still water in about 400 lakes and portions of about 100 streams totaling about 700 miles. Closures are for purposes of security and protection of nesting waterfowl.

#### Value of Federal Wildlife Resources

The value of the fish and wildlife resources on Federal lands is virtually unknown. Except for fur and commercial fish, there are no identifiable markets for fish and wildlife products from which to derive estimates of value. And even if such market values were available, they would measure only the commercial aspects of the resource. Recreational, social, esthetic and similar non-monetary and intangible values would be ignored.

About all that is known about the value of the wildlife resource is that it is high, based upon measures of what consumptive and appreciative recreation users have spent and would have been willing to spend. For consumptive users, the 1965 National Survey of Fishing and Hunting (4) shows that expenditures by hunters and fishermen totaled \$1.12 and \$2.93 billion, respectively. An estimate of what 1965 consumptive users would have been willing to spend to pursue their sport is \$9.9 billion, only \$4.05 billion of which was actual expenditure. The user value of bird watchers, one type of appreciative user, has been estimated at \$3.20 billion (1).

#### Future Role of the Federal Lands

Future demands upon Federal lands as a source of habitation for wildlife will depend to a large extent upon the growth in number of people who want to use these lands as a place to hunt, fish, observe, appreciate and otherwise "consume" wildlife. Specific estimates of future populations of birdwatchers, wildlife photographers and other naturalists, and of the magnitude of future non-user demands

TABLE 9. --Fishing Waters Located on Certain Federal Lands in 20 States<sup>a/</sup>

State	Forest Service		Bureau of Land Management		Corps of Engineers <sup>b/c/</sup>		Bureau of Reclamation		Navy	
	Streams (Miles)	Lakes (Acres)	Streams (Miles)	Lakes (Acres)	Streams (Miles)	Lakes (Acres)	Streams (Miles)	Lakes (Acres)	Streams (Miles)	Lakes (Acres)
Arizona	880	9,066	-	1,278	-	-	-	373,529d/	-	-
Arkansas	1,813	32,508	-	-	-	156,000	-	-	-	-
California	11,640	244,210	228	629	-	82,100	-	115,206	-	21,283
Colorado	6,580	31,029	493	1,553	-	900	-	40,487d/	5	-
Florida	356	59,932	-	-	-	503,400	-	-	9	152
Idaho	11,105	135,202	327	863	-	97,400	-	131,419d/	-	-
Michigan <sup>e/</sup>	2,361	86,298	-	-	-	258,500	-	-	-	-
Minnesota <sup>e/</sup>	1,969	641,357	-	-	-	212,000	-	127,125d/	-	-
Montana	5,810	94,985	3,020	2,677	-	-	-	24,069	-	17,010
Nevada	938	50,240	516	442	-	-	-	-	-	-
New Hampshire	439	1,727	-	-	-	1,100	-	-	-	-
New Mexico	1,309	500	30	1,837	-	3,300	-	39,259	-	-
North Carolina	4,146	30,500	1,846	2,418	-	4,100	-	-	37	32
Oregon	7,892	83,270	-	-	-	51,200	-	56,364	-	-
South Dakota	339	9,771	-	-	-	20,276	-	20,276	-	-
Utah	2,574	32,868	433	1,071	-	493,600	-	71,568	15	60
Virginia	834	1,975	-	-	-	56,100	-	-	42	1,549
Washington	4,946	138,409	-	-	-	72,800	-	152,798	5	1,524
West Virginia	587	265	-	-	-	20,700	-	-	-	-
Wyoming	4,524	43,982	543	2,582	-	-	-	142,983	-	-
Totals	71,052	1,728,094	7,436	15,350	-	2,013,200	-	1,295,083	113	41,610

<sup>a/</sup> Data compiled from reports of the Corps of Engineers (1964), Bureau of Reclamation (1965), and the Forest Service (1965), and from 1966 data compiled especially for this report by the Bureau of Land Management and the Navy. Comparable data was not available for other agencies.

<sup>b/</sup> Acres are for reservoirs of normal recreational pool level. Includes some natural lakes which are partially controlled by Corps of Engineers dams.

<sup>c/</sup> Some of the reservoirs included here may be located on federal lands under jurisdiction of other agencies, and therefore included in their acreage totals also.

<sup>d/</sup> Includes all reservoirs forming the border waters with adjacent states.

<sup>e/</sup> Excludes waters of the Great Lakes.



to provide wildlife habitat just for the sake of having wildlife are not available. However, the growth trends indicated by the Nathan Associates (2) projections of future participation in "back country recreation" (fishing, hunting, hiking and camping) provide an indicator of the magnitude of potential pressures by both consumptive and appreciative users. A proxy for pressure by just consumptive users is available in the form of the trends represented by projections of fishing and hunting license holders, also developed by Nathan Associates.

The Nathan medium projections of 1980 and 2000 participation in back country recreation is summarized in Table 10. The data shown are indexes (1965 equal to 100) rather than actual participation rates. Total participation in back country recreation is projected to increase by only 12 percent over the 1965 level by 1980 and only by 13 percent by 2000. The modest national increase is a result of increasing urbanization. Participation per unit of population is expected to decline as the country becomes more urbanized. Total wildlife-oriented recreational use will increase by only 1.3 times over current use by 2000.

Medium-level projections of hunting- and fishing-license holders, expressed as indexes, are also presented in Table 10. In accord with past trends in numbers of licenses per 100 population, fishing license holders are expected to increase from 10.54 in 1965 to 18.60 per 100 population in 2000, while hunting license holders are expected to decline from 7.37 in 1965 to 6.73 per 100 population in 2000. The projections of total license holders show that by 1980 there will be 1.4 times as many hunters and 2.8 times as many fishermen in the United States than there were in 1955.<sup>3/</sup> Demands for wildlife to hunt and fishing waters to fish will increase accordingly.

Assuming that the trends shown in Table 10 are reasonable indicators, there still remains the question of what impact these trends will have on Federal lands. The only reasonable conclusion that can be drawn from available data is that pressures on public lands will increase at no less of a rate and probably at a greater rate than on private lands. How much of this burden will be assumed by Federal as opposed to state agency lands is a matter of policy yet

<sup>3/</sup> Bureau of Sport Fisheries and Wildlife estimates of the number of fishermen in 2000 presented in the National Survey of Needs for Hatchery Fish (3) are lower. The Bureau of Sport Fisheries and Wildlife projections show that there will be only 2.2 times as many fishermen in 2000 than there were in 1965.

Table 10.--Projected Increases in Back Country Recreation, Fishing Licenses and Hunting Licenses, by Region, 1980 and 2000

(1965=100)

Region	1965	Back-Country Recreation		Fishing licenses		Hunting licenses	
		1980	2000	1980	2000	1980	2000
Northeast	100	120	151	143	241	113	133
North Central	100	106	121	133	228	105	128
South	100	110	135	181	324	120	149
Mountain:							
Montana	100	100	111	)			
Idaho	100	100	111	)			
Wyoming	100	100	125	)			
Colorado	100	100	110	)			
New Mexico	100	114	143	)			
Arizona	100	129	167	)	167	325	128
Utah	100	115	146	)			
Nevada	100	133	133	)			
West Coast:							
Washington	100	107	110	)			
Oregon	100	104	115	)			
California	100	124	147	)			
Total <sup>a/</sup>	100	112	134	156	282	115	143

<sup>a/</sup> Excludes Alaska and Hawaii.

Source: (2).



to be decided. At least for hunting, the current comparatively light harvest relative to game population on Federal lands would indicate the ability of Federal lands to absorb additional hunting pressure.

What this increased pressure means in terms of wildlife habitat management is equally vague. For example, the Forest Service, Bureau of Land Management, and Bureau of Sport Fisheries and Wildlife have estimated that 16.6 million acres of big game range land under their jurisdictions in the 11 Western States is in need of some type of rehabilitation treatment. Because of a lack of knowledge, it is not possible to estimate the impact of rehabilitation of this area on game population (much less hunter success) with reasonable accuracy. Again, the only conclusion that can be drawn at this time is that based on recent trends there will be continued public interest in the provision of a natural environment for wildlife, the protection of endangered species and the like. These pressures will come from both consumptive users and from those concerned with wildlife as a part of the natural environment and therefore deserving of stewardship and husbandry.

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## CHAPTER IV

### OUTDOOR RECREATION

Outdoor recreation is a very broad classification of activities. A partial list includes walking or driving for pleasure, participating in or watching outdoor games or sports, bicycling, swimming, sightseeing, skiing, water skiing, boating, hunting, fishing, horseback riding, hiking, nature walks, picnicking, camping, rock collecting, bird watching, and snowmobiling.

Areas and facilities required for the diverse recreation activities are also highly diverse. One broad classification distinguishes among user-oriented areas, resource-based areas and intermediate areas (2). User-oriented areas, such as city parks or playgrounds, are close to users, usually small in size (frequently from a few to a few hundred acres), and intensively developed; their use is closely correlated with the free time available each day. Resource-based areas have outstanding physical resources as their prime characteristic. Usually, they are large areas (some thousands of acres in size), at considerable distance from population concentrations, and their use is typically vacation-time use. Intermediate areas lie between the extremes, both geographically and in terms of use. They are typically within several hours' driving time, are used for all-day outings and on weekends.

#### Trends in National Outdoor Recreation Activity

Outdoor recreation, stimulated by a variety of factors including expanding population, higher incomes, more leisure, greater mobility, and urbanization, has expanded very rapidly. The indications are reflected in construction of commercial recreation facilities, increased sales of outdoor recreational equipment, and increasing numbers of visits to recreational areas. Yet few data sources are available to document comprehensively the extraordinary rise in outdoor recreational activity.

One estimate by Clawson and Knetsch (1) of historical expansion in outdoor recreation is in terms of man-hours of activity. The estimate shows 7.8 billion man-hours in 1940, 12.2 billion in 1950, and 21.0 billion in 1960; the 20-year increase in time spent on outdoor recreation is about 170 percent.

The Bureau of Outdoor Recreation (BOR) published tabulations of a 1965 survey of participation in outdoor recreation activities under the title Outdoor Recreation Trends (9). The data in this study, gathered by the Bureau of the Census, were designed to achieve comparability with data compiled for 1960 by the Outdoor Recreation Resources Review Commission (ORRRC) (7).

The 16 activities recorded in Table 1 are not all-inclusive, but they account for the bulk of summertime outdoor recreation. A total of 6,476 million recreation occasions was calculated for 1965, a 51 percent increase over the 4,282 million occasions calculated by ORRRC for the same activities in 1960. The increase recorded in 1965 by the Bureau of Outdoor Recreation was almost 70 percent of the expected 20-year increase projected by ORRRC from 1960 to 1980. The number of individuals participating in each of the 16 activities listed increased from 1960 to 1965, and the average number of participating occasions per individual increased for every activity except horseback riding.

#### Projections of National Outdoor Recreation Activity

The ORRRC predictions, made from a 1960 base, were that summertime outdoor recreation activities would increase 187 percent by the year 2000 (5).

With its new survey in 1965, and the finding that participation in 16 major summertime activities had increased 51 percent from 1960 to 1965 (in contrast to ORRRC's projection of a 20 percent increase), the Bureau of Outdoor Recreation projected the following increases (9):

<u>Period</u>	<u>Percent Increase</u>
1965-1980	137
1980-2000	66
1965-2000	160

Details of the projected increases are summarized in Table 2. Chief interest centers in the overall changes since probabilities for error are much greater when individual activities



Table 1.--Millions of Occasions of Participation in 16 Major Summertime Outdoor Recreation Activities, 1960 and 1965

Activity	No. of Occasions			No. Individuals		
	1960	1965	5-Year Increase	1960	1965	5-Year Increase
			%			%
Walking for pleasure	566	1,030	82	43.1	67.8	57
Swimming	672	970	44	58.7	67.8	15
Driving for pleasure	872	940	8	67.9	77.7	14
Playing outdoor games or sports	474	929	96	39.2	53.7	37
Bicycling	228	467	105	11.7	22.6	92
Sightseeing	287	457	59	54.8	69.2	26
Picnicking	279	451	62	69.2	80.5	16
Fishing	260	322	24	37.8	42.4	12
Attending outdoor sports events	172	246	43	31.3	42.4	35
Boating	159	220	38	28.7	33.9	18
Nature walks	98	117	19	18.3	19.8	8
Camping	60	97	62	10.4	14.1	35
Horseback riding	55	77	40	7.8	11.3	44
Water skiing	39	56	44	7.8	8.5	8
Hiking	34	50	47	7.8	9.9	26
Attending outdoor concerts, plays	27	47	74	11.7	15.5	32
Total	4,282	6,476	51	a/	b/	

a/1960 United States population of individuals 12 years and older, 130.5 million.

b/1965 United States population of individuals 12 years and older, 141.3 million.

Source: Data from (9).

Table 2.--Millions of Occasions of Participation in 16 Major Summertime Outdoor Recreation Activities, 1965 and Projected 1980 and 2000

Activity	Millions of Occasions			Percentage Changes	
	1965	1980	2000	1965-1980	1965-2000
Walking for pleasure	1,030	1,539	2,581	49	151
Swimming	970	1,671	2,982	72	207
Driving for pleasure	940	1,423	2,146	51	128
Playing outdoor games or sports	929	1,594	2,940	72	216
Bicycling	467	617	860	32	84
Sightseeing	457	705	1,169	54	156
Picnicking	451	668	1,022	48	127
Fishing	322	422	574	31	78
Attending outdoor sports events	246	352	535	43	117
Boating	220	387	694	76	215
Nature walks	117	173	274	48	134
Camping	97	173	328	78	238
Horseback riding	77	111	169	44	132
Water skiing	56	124	259	121	363
Hiking	50	89	159	78	218
Attending outdoor concerts, plays	47	80	144	70	206
Total	6,476	10,128	16,846	56	160

Source: Data from (9).



are considered. Four activities--swimming, playing outdoor games or sports, walking for pleasure, and driving for pleasure--are predicted to account for 63 percent of the total participations in the 16 activities listed.

ORRRC's predictions of future outdoor recreation activity rested on a series of projections--total population, gross national product, per capita disposable income, hours of work per week, weeks of paid vacation, and per capita miles of intercity travel. The Bureau of Outdoor Recreation may have used the same factors, but this is not explained in its report on Outdoor Recreation Trends (9).

The Nathan Report (8) used the 1965 Bureau of Outdoor Recreation survey as the basis for its projecting participating occasions to 1980 and 2000. The Nathan Report covered 22 activities and used, additionally, unpublished data gathered by the Bureau of the Census for Bureau of Outdoor Recreation showing the percentage of the population 12 years and over participating in each activity and the number of participating occasions per participant. Its projections were based on the same variables as were used by ORRRC--per capita real disposable income, per capita intercity automobile travel, weekly hours of leisure per employed person, population--and included additionally, growth rate in metro-urbanization.

The 1965 participating occasions used as the point of departure in the Nathan Report differ inexplicably from the Bureau of Outdoor Recreation reported figures. Therefore, attention has been focused only on the percentage increases projected, and comparisons have been made with the Bureau of Outdoor Recreation projected percentage increases.

Activities were grouped into five categories in the Nathan Report: passive outdoor recreation, physically active recreation, water sports, back country recreation, and winter sports.<sup>1</sup> Since data for winter sports are not expressed in terms of participating occasions, and they are

<sup>1</sup>/Passive outdoor recreation includes: walking for pleasure, driving for pleasure, sightseeing, attending outdoor sports events, picnicking, nature walks, and attending outdoor concerts and plays. These activities were all covered in the Bureau of Outdoor Recreation report.

Physically active recreation includes: playing outdoor games or sports, bicycling and horseback riding. These activities were all covered in the Bureau of Outdoor Recreation Report.

Water sports include: swimming, boating, canoeing, sailing, water skiing. Canoeing and sailing, minor activities in terms of participation, were not included in the BOR report.

Back country recreation includes: fishing, camping, hiking, hunting. Hunting was omitted in the BOR report because it is largely a nonsummertime activity.

Winter sports include: sledding, skiing, ice skating. These activities were not covered in the BOR survey.

unclear in definition, they have been omitted from the summary presented here.

In overall terms, the Nathan Report projects recreation activities participation up 60 percent to 1980 and 141 percent to 2000 (Table 3). These projections are not radically different from the corresponding Bureau of Outdoor Recreation projections of 56 percent and 160 percent. Differences are more pronounced by activity category. Because the Nathan Report includes hunting and fishing in back-country recreation (activities which are not expanding as rapidly as most of the activities recognized), it projects little increase in back country activities.

#### Outdoor Recreation on the Public Lands

The data on participation in recreation activities--reflecting the great diversity of outdoor recreation activities, the rapid increases in these activities, and the projections of large increases in future activities--are difficult to relate in any direct way to past or future participation in the same activities on the Federal lands.

Some activities, like attending outdoor sports events or concerts and plays, are tied to facilities more likely to be found in user-oriented areas than in resource-based areas. Camping and mountain climbing are more closely oriented to the space and physical features to be found on the Federal lands. However, most recreation activities can be conducted in a great variety of locations--in urban areas, intermediate areas, and on the Federal lands.

The great bulk of recreation activities occurs and will continue to occur in and close to the population centers. Proximity and ready availability are overriding factors. But the quality of recreational experiences is a dimension that puts the Federal lands in a different light. Space, landscape, attractiveness and other features of the Federal lands may draw different groups of people, or some of the same groups more intensively, than the more limited user-oriented areas. The satisfactions provided are different. Moreover, with increasing urbanization, greater mobility of population and increasing per capita income, the demand for resource-oriented areas (as exemplified by the Federal lands) can be expected to become relatively more intense than the demand for recreational activity in the user-oriented areas.



Table 3.--Comparison of Nathan Report and Bureau of Outdoor Recreation Report Projections of Participation in Major Outdoor Recreation Activities, 1965 to 1980 and 2000

Activity Category	(Percentage Increase)			
	Nathan Report <sup>a/</sup>		Bureau of Outdoor Recreation Report	
	1965 to 1980	1965 to 2000	1965 to 1980	1965 to 2000
Passive outdoor recreation <sup>b/</sup>	62	134	50	139
Physically active recreation <sup>c/</sup>	88	167	51	170
Water sports <sup>d/</sup>	89	171	75	216
Back-country recreation <sup>e/</sup>	13	34	43	122
Total	60	141	56	160

<sup>a/</sup> Medium-level projections.

<sup>b/</sup> Walking and driving for pleasure, sightseeing, attending outdoor sports events and concerts and plays, picnicking, nature walks.

<sup>c/</sup> Playing outdoor games or sports, bicycling and horseback riding.

<sup>d/</sup> Swimming, boating, water skiing. Nathan Report includes canoeing and sailing additionally.

<sup>e/</sup> Fishing, camping, hiking. Nathan Report includes hunting additionally.

Source: Data from (8) and (9).

ORRRC reported outdoor recreation visits to all public recreation areas in 1960 (6), but there is no way of comparing these figures with any total representing recreation visits to privately owned areas. The 4.3 billion occasions of participation in summertime outdoor recreation activities estimated for 1960 were not considered in terms of location of activity, and the relationship of number of visits to number of participating occasions is unknown. The 566 million visits reported by public agencies to ORRRC undoubtedly represents a large proportion of the total outdoor recreation activity in 1960.

The breakdown of 1960 visits to public areas--daytime visits, 40 percent to Federal areas, 42 percent to state areas, and 18 percent to local areas; overnight visits, 64 percent to Federal areas, 34 percent to state areas, 2 percent to local areas--shows one aspect of the major role of the Federal lands. Federal lands account for 40 to 50 percent of the recreational visits to public lands.

#### Area of Public Recreation Lands

The public lands classified by managing agencies as suitable for recreation total about 400 million acres (Table 4). At least 91 percent of the total is in Federal ownership; most of the rest is in state ownership. State and local lands are distributed broadly across the country, but the extensive Federal lands are highly concentrated in the West.

Water areas are a basic requirement of many recreation activities and an important adjunct to most. In total, nearly 5 million acres of water surface are located on the Federal lands (Table 5). The acreage is largest in the West, but extensive in both the South and North Central regions.

A major portion (about 80 percent) of the Federal recreation lands is classed as natural environment area under the Bureau of Outdoor Recreation classification scheme<sup>1/</sup> (Table 6). Such areas, characterized by attractive natural settings, access roads, trails, and campsite facilities, are available to the public largely on Federal and state lands. About 12 million acres of outstanding natural areas and 45 million acres of primitive areas are outstanding features of the Federal recreation landownership.

<sup>1/</sup> The classification scheme is set out in detail in (4, p. 40).



Table 4.--Public Lands Classified by Managing Agencies as Suitable for Recreation, by Census Region and Agency, 1967

(Million Acres) <sup>a/</sup>					
Agency	United States	West	South	North Central	North-East
Federal <sup>b/</sup>					
Natl. Park Service	19.6	15.4	3.3	0.8	0.1
Bur. Land Management	172.4	172.4		0.1	
Bur. Sport Fisheries & Wildlife Service	6.4	4.2	1.3	0.8	0.1
Bur. Reclamation	0.3	0.3			
Forest Service	161.3	137.8	12.7	9.4	1.4
Total	360.0	330.1	17.3	11.1	1.6
State	33.1	8.5	9.7	10.5	4.4
Local	3.5	0.5	0.3	2.5	0.2
All Public	396.6	339.1	27.3	24.1	6.2

<sup>a/</sup> Figures may not add to totals due to rounding.

<sup>b/</sup> The principal Federal agency omissions relevant to recreational use are the Army Corps of Engineers and the Tennessee Valley Authority. The Corps of Engineers administers over 8 million acres of land in 44 states, including 350 reservoirs. Recreation is a major use of the Corps' reservoir sites. Similarly, the Tennessee Valley Authority has 1.0 million acres of reservoir land on which recreation is accepted as a major use.

Source: Table data from (3). Footnote data from (4).

Table 5.--Water Surface Acreage on Federal Recreation Lands, by Census Region and Agency, 1967

(Thousand acres) <sup>a/</sup>					
Agency <sup>b/</sup>	United States	West	South	North Central	North-east
National Park Service	1,795	687	672	406	30
Bur. Land Management	366	365			
Bur. Sport Fisheries & Wildlife Service	1,193	423	555	204	11
Bureau Reclamation	199	190		10	
Forest Service	1,187	660	77	447	3
Total	4,740	2,325	1,304	1,067	44

<sup>a/</sup> Figures may not add to totals due to rounding.

<sup>b/</sup> The principal federal agency omissions relevant to recreational water use are the Army Corps of Engineers and the Tennessee Valley Authority. The Corps of Engineers administers 28,000 miles of improved inland and intercoastal waterways and 350 reservoirs. The Tennessee Valley Authority has fee control and easement rights to 10,000 miles of reservoir shoreline. TVA lakes have about 60,000 surface acres.

Source: Table data from [3]. Footnote data from [4].



Table 6.--Public Recreation Lands Classified by BOR System,  
by Census Region, 1967

BOR Class	Public Ownership	R e g i o n				
		United States	West	South	North Central	North- east
(Million acres) <sup>a/</sup>						
I <sup>b/</sup>	Federal	0.1	0.1			
	State & local	0.3	0.1	0.1	0.1	0.1
II <sup>c/</sup>	Federal	11.0	10.5	0.3	0.1	
	State & local	2.8	0.9	1.2	0.5	0.2
III <sup>d/</sup>	Federal	290.5	263.8	15.3	9.9	1.6
	State & local	31.4	7.5	7.7	12.2	3.9
IV <sup>e/</sup>	Federal	11.9	11.1	0.6	0.2	
	State & local	0.5	0.1	0.1	0.1	0.1
V <sup>f/</sup>	Federal	44.9	42.8	0.9	0.9	
	State & local	1.5	0.4	0.8	0.2	0.2
VI <sup>g/</sup>	Federal	1.6	1.5	0.1		
	State & local					
Total	Federal	360.0	330.0	17.4	11.1	1.6
	State & local	36.5	9.0	10.0	13.1	4.5

a/ Figures may not add to totals due to rounding.

b/ High density recreation areas. Intensively developed. Usually within or near urban population centers.

c/ General outdoor recreation areas. Relatively accessible to urban centers. Generally less intensive facility development than Class I.

d/ Natural environment areas. Attractive natural settings. Usually more remote from urban centers than Class I or II. Access roads, trails, campsite facilities and minimum sanitary facilities. There may be other compatible uses.

e/ Outstanding natural areas. Individual areas of remarkable natural wonder, high scenic splendor, or features of scientific importance. Facilities limited.

f/ Primitive areas. Usually remote from population centers. Extensive areas. No development of public roads, permanent habitations or recreation facilities except trails.

g/ Historic and cultural sites. Access adequate, but onsite development limited to prevent deterioration.

Source: Data from [3].

#### Facilities on Public Recreation Lands

Except for the primitive areas, where the construction of facilities is prohibited, recreational use depends on the availability of facilities as well as land. State and local areas have more of the facilities required for intensive daytime recreation than the Federal lands--swimming beaches, parking spaces, picnic tables, boat access parking, and marina slips (Table 7). Tent and trailer campgrounds are fairly well divided between Federal and state and local areas. The Federal lands, because of distance from population centers, supply most of the cabin, hotel, and motel facilities.

#### Recreational Visits to Public Lands

In 1960, visits to Federal recreation areas totaled 384 million, distributed by agency as follows (8):

	Million Visits
Army Corps of Engineers	109
Forest Service	93
National Park Service	72
Tennessee Valley Authority	42
Bureau of Reclamation	24
Bureau of Land Management	17
Bureau of Sport Fisheries & Wildlife	11
Department of Defense	16

From 1960 to 1965, increases in visits were registered for all agency lands. Federal agencies, as a whole, had a 56 percent increase; state agencies, 43 percent. Among Federal agencies, recreation visits expanded fastest for the Forest Service (73 percent), Park Service (68 percent), Bureau of Land Management (59 percent), Army Corps of Engineers (55 percent), and Bureau of Reclamation (50 percent) (8).

An historical series of recreational visits is presented in Table 8 for the national parks, other Park Service areas, the national forests, and wildlife refuges. These lands accounted for 49 percent of the total recreational visits to all Federal lands in 1965. From 1948 to 1967, visits to national parks increased 263 percent; to other Park Service areas, 438 percent. Visits to National forests increased 571 percent from 1948 to 1965, at which time the Forest Service changed its record-keeping from visits



Table 7.--Recreation Facilities on Public Lands, by Agency, 1965

Type of Facility	Federal					State and Local
	Total	Nat. Park Serv.	Bur. Land Mgt.	Bur. Sport F & W Serv.	Bur. Reclamation	
Tent campgrounds (thous. acres)	34.4	5.7	4.2	0.5	0.7	23.3
Trailer campgrounds (thous. acres)	6.8	0.6	2.0	0.3		3.9
Swimming beaches (thous. acres)	4.9	0.3	1.1	2.9		0.6
Cabins and motels (thous. units)	12.2	9.2	0.1	0.2	2.6	15.0
Hotel and lodge beds (thous. units)	22.8	8.4		0.1	14.3	6.0
General parking spaces (thous. units)	219.9	124.7	6.9	12.4	2.5	73.5
Picnic tables (thous.)	47.2	11.2	1.3	2.4	0.5	1,642.6
Boat access parking spaces (thous.)	31.6	11.7	0.4	9.7	0.6	31.7
Marina slips (thous.)	7.9	3.5		2.6	0.2	9.2
						1.6
						40.3

Source: Data from [3].

Table 8.--Recreational Visits to National Parks, Other Park Service Administered Areas, National Forests, and Wildlife Refuges, 1948-67

Year	National Parks <sup>a/</sup>	Other Park Service <sup>a/</sup>	National Forests <sup>b/</sup>	Wildlife Refuges <sup>c/</sup>
(Million visits)				
1948	10.9	18.6	23.9	
1949	12.6	18.8	26.0	
1950	13.5	19.3	27.2	
1951	14.6	22.0	29.7	3.4
1952	16.4	30.2	32.7	4.3
1953	16.9	34.8	35.1	4.7
1954	17.5	36.2	40.0	5.2
1955	18.4	37.7	45.3	7.0
1956	19.5	41.5	52.1	7.6
1957	20.4	47.0	60.4	8.7
1958	21.2	43.6	67.7	9.1
1959	21.6	46.3	80.5	9.9
1960	25.8	52.4	91.3	10.6
1961	27.0	58.5	100.6	11.0
1962	32.4	63.9	111.5	10.8
1963	32.7	69.1	120.9	12.4
1964	33.3	75.0	132.4	13.9
1965	35.9	82.3	160.3	12.9
1966	38.6	94.5		13.8
1967	39.6	100.0		17.7

a/ Data refer to 48 contiguous states through 1965, 50 states in 1966 and 1967. Alaska and Hawaii accounted for 0.7 million visits in 1965 in national parks and 0.4 million visits in other Park Service areas.

b/ Data not shown for 1966 and 1967 because of change in reporting units from "number of visits" to "visitor days." A visitor day aggregates 12 person-hours of recreational use. Visitor days reported by the Forest Service for the national forests are as follows: 137 million in 1966, 151 million in 1967, and 166 million in 1968. Roughly, 1.5 visits equals 1 visitor day.

c/ Data refer to 48 contiguous states through 1964, 50 states in 1965-67.

Source: Agency reports.



to visitor-days; visitor-days increased 21 percent from 1966 to 1968. Wildlife refuge visits increased 420 percent from 1951 to 1967. The compound annual rates of increase are: national parks, 7.0 percent; other National Park Service areas, 9.2 percent; national forests, 11.8 percent; wildlife refuges, 10.8 percent. For the four categories of Federal lands combined, the compound annual rate of increase is in excess of 10 percent.

#### Projection of Recreational Visits to Federal Lands

The Nathan Report (8) projected recreational visits to Federal lands under four agency designations: national parks, other National Park Service areas, national forests, and wildlife refuges. Determinants used to project overall participation in outdoor recreation activities--per capita real disposable income, per capita intercity automobile travel, weekly hours of leisure per employed person, and rate of metro-urbanization--were not considered as reliable for projecting visits to the four categories of Federal land considered as in explaining past performance. Estimating equations were based on developing consumer preferences, as measured by the historical record of visits over time, and per capita real disposable income. However, the equations were not developed in the same form for the four categories of Federal land.

The results of the projections are summarized in Table 9. National park visits are projected up 507 percent from 1965 to 2000; other National Park Service areas, 256 percent; national forests, 498 percent; wildlife refuges, 504 percent. The individual projections are difficult to accept. For example, over the 20-year period 1948-67, national park visits increased 263 percent and national forest visits increased about 830 percent; yet the projections indicate that national park visits will increase at a slightly higher rate than national forest visits.

On an overall basis, the 25-year projection to the year 2000 indicates a 465 percent increase in recreation visits. Large as the increase is, it gains credibility from the fact that the overall increase was 615 percent for the past 20 years. The historical compound rate of annual increase for recreational visits to the Federal lands has been in excess of 10 percent; the projected rate of increase to the year 2000 is 4.9 percent.

State park visits were projected on the assumption that the ratio of state park visits to national park visits

Table 9.--Recreational Visits to Federal Lands and State Parks, by Agency, 1965 and Projected to 1980 and 2000

(Million Visits)

Year	Natl. Park Service		National Forests	Wildlife Refuges	State Parks <sup>a/</sup>
	Natl. Parks	Other			
1965 (actual)	35.9	82.3	160.3	12.9	420.2
1980	84.0	148.2	433.0	39.8	1,290.6
2000	217.8	293.3	958.7	77.9	4,118.1

<sup>a/</sup> Regional data compiled in 1965 show 62 percent of the visits in the North, 17 percent in the South, and 21 percent in the West. Projections to 1980 show the following percentage relationships: 49 percent North, 25 percent South, and 26 percent West. The corresponding figures for year 2000 are: 49 percent North, 28 percent South, and 23 percent West.

Source: Projection data from (8).



will continue to increase in the future at about the same rates as in the past; the resulting ratio will be 15 to 1 in 1980 and 19 to 1 in the year 2000. This assumption is based on expectations that state parks will continue to serve as higher intensity recreation areas, particularly as weekend recreational facilities near metropolitan areas. The projection indicates an increase in state park visits from 420 million visits in 1965 to 4,118 million visits in 2000.

#### Constraints on Projections of Recreational Visits to Federal Lands

The projection of recreational visits to the Federal lands at an average compound annual rate of 4.9 percent is conservative in view of the historical experience of a more than 10-percent annual rate. Nevertheless, the projected absolute increases in visits to Federal lands (national parks, other National Park Service areas, national forests, and wildlife refuges) from 291 million in 1965 to 1,548 million in the year 2000 are of such magnitude as to raise serious questions about attainability.

In part, the projections must be related to the projections for other public lands. State park visits are projected from 420 million to 4,118 million. Whether state parks will be able to accommodate such a large volume of use is questionable. The question is not simply whether states can acquire additional lands, funds, and facilities to handle an 880-percent increase in recreational use, but to what extent the attempt will fail to meet the kinds of demand for outdoor recreation which require space and lack of human congestion. The desire for space and attractive natural settings is more likely to shift future recreation demand from state and local areas to Federal lands than the reverse.

The extensiveness of the Federal lands is not, by itself, an indication that the projected increases in recreational use can be accommodated. The Federal lands are concentrated in the West, and the physical characteristics valued by consumers do not permit simple interchanging of acres. Yosemite National Park has 758,000 acres. Dispersing 1.5 million visitors over this area would mean roughly 2 visitors per acre. Most of the visitors, however, spend most of their time on the 10,000-acre Yosemite Valley floor, which means a concentration of about 150 visits per acre. The actual degree of congestion depends on the distribution of visits over time, but a large portion of the annual visits occurs during a few months of the year. The physical

limitation--in terms of psychological reaction to congestion, the facilities that can be provided without impairing the attractions of the area, and the ability of the land to withstand such heavy use without deterioration--does not permit the amount of expanded use as is reflected in the projections of national park visits. Some of the projected increase must shift to presently less-used acres. The effect of shifting recreational use from intensively used acres of preferred areas to less-used acres which may not be as attractive to users is unknown. However, if the overall projections have validity and it can be assumed that greatly expanded use can accommodate to the use of presently less-preferred areas, the acres needed are available on the Federal lands.

An important ingredient of providing for recreational use is the investment in facilities--such as access roads; camping, picnicking, and parking facilities; food and lodging; beaches and marinas; water supply and sewage handling--and management. It is possible, with adequate investment, to add greatly to the intensity of use and to bring little-used areas of the Federal lands into use. Budget program levels of 1967--such as \$126 million for the National Park Service and \$39 million for the Forest Service--will have to be expanded vastly to accommodate the projected expansions in recreational use. The projections imply that the supply of land and facilities in relation to recreational use will at least be maintained in the same ratio as at present.

A further policy question revolves around the commitment which Federal agencies will be willing to make to recreational use in view of major commitments to other resource demands. Only the National Park Service has recreation as its primary management responsibility. Yet, even in this instance, with some groups in the consuming public seeking expansion of intensive recreation while other groups seek additional land dedications to primitive areas, it will be very difficult to build toward projected volumes of use while maintaining any reasonable balance in meeting the different use demands. The Corps of Engineers, the Tennessee Valley Authority, the Bureau of Reclamation, the Bureau of Sport Fisheries and Wildlife, and the Department of Defense all have major responsibilities other than recreation claiming their attention. These agencies, to varying degree, accept outdoor recreational use and are providing for expansion of this responsibility, but the extent to which they will continue to do so as the volume of use builds up and results in increasing land and water use conflicts involving their prior management interests is unknown.



The major landholding agencies--the Forest Service and the Bureau of Land Management--have historic attachments in places to particular resource uses but, in theory at least, all uses including recreation are entitled to equal consideration. The problem of accommodating use expansions still remains. As the demands build up for a variety of uses against a relatively fixed land base, conflicts arise inevitably. Resolution of the conflicts may mean less water, timber, forage or other resources than would be possible under specific management for a particular use, but it may also mean that less recreation will be supplied or, at least, less of the recreation demanded by those groups of users who see other land uses as destructive to recreational values.

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## CHAPTER V

### TIMBER

This chapter summarizes the historical trends in United States timber production, projections of United States timber production to 1980 and 2000, historical trends in timber production on the public lands, and projections of timber production on the public lands. The potential role of the public lands in contributing to future timber supply is examined both in terms of the extension of present agency policies and the intensification of timber management.

#### Trends in United States Timber Production

Primary log products are identified as sawlogs, veneer logs, pulpwood, miscellaneous log products, and fuelwood. Sawlogs, veneer logs, and pulpwood are the major products.

#### Round Timber Production

Trends in production have varied by product, but the net effect has been an essentially stable pattern in overall log production (Table 1). Log production totaled 10.8 billion cubic feet in 1947, 10.6 billion in 1963. The trend was nearly horizontal over the 16-year period. Production moved up in 1964 and reached 11.8 billion cubic feet in 1968, an 11-percent increase over 1963 production.

#### Sawlogs

Sawlogs, which are manufactured into lumber, have been historically the major timber product in the United States. The trend in sawlog production has been nearly horizontal over the period 1947-1968. Production was 5.5 billion cubic feet in 1947, 5.7 billion in 1968.

Sawlog production data are not available by species groups, but lumber production data are available, and the

Table 1.--Production of Timber Products in the United States, by Major Product, 1947-1968<sup>a/</sup>  
(Billion cubic feet)

Year	All Products	Industrial Roundwood					Log Ex-ports <sup>c/</sup>	Fuel-wood <sup>b/</sup>
		Total	Saw-logs	Veneer logs	Pulp-wood	Other <sup>b/</sup>		
1947	10.8	8.1	5.5	0.3	1.4	0.9		2.7
1948	11.0	8.4	5.7	.3	1.5	.8		2.7
1949	10.2	7.3	5.0	.3	1.3	.7		2.8
1950	10.8	8.5	5.9	.3	1.5	.8		2.3
1951	11.0	8.7	5.8	.4	1.8	.7		2.2
1952	10.8	8.8	5.8	.4	1.8	.7		2.0
1953	10.7	8.8	5.7	.5	1.9	.7		1.9
1954	10.6	8.7	5.6	.5	2.0	.7		1.8
1955	10.9	9.2	5.8	.6	2.2	.6		1.7
1956	11.3	9.6	5.9	.6	2.5	.6		1.7
1957	10.2	8.6	5.1	.6	2.4	.6		1.6
1958	10.0	8.5	5.2	.6	2.1	.6		1.5
1959	10.8	9.3	5.7	.7	2.3	.5		1.4
1960	10.2	8.9	5.1	.7	2.6	.5		1.3
1961	9.9	8.6	4.9	.8	2.4	.5	0.1	1.2
1962	10.2	9.0	5.1	.8	2.6	.5	.1	1.1
1963	10.6	9.3	5.4	.9	2.6	.5	.1	1.1
1964	11.4	10.1	5.6	1.0	3.0	.5	.2	1.1
1965	11.5	10.3	5.7	1.0	3.1	.5	.2	1.1
1966 <sup>d/</sup>	11.6	10.4	5.6	1.0	3.2	.5	.2	1.0
1967 <sup>d/</sup>	11.3	10.0	5.4	1.0	3.1	.5	.3	1.0
1968 <sup>d/</sup>	11.8	10.5	5.7	1.1	3.2	.5	.4	1.0

<sup>a/</sup> Columns may not add to totals because of rounding.

<sup>b/</sup> Estimates of consumption considered to be equivalent to production.

<sup>c/</sup> Unidentified by product.

<sup>d/</sup> Preliminary estimates.

Source: Data for 1947-49 from (5); data for 1950-68 from (6).



relationships among sawlog categories can be considered virtually synonymous with those in lumber. Softwood lumber production, which has held steady at about 80 percent of total lumber production, has had a horizontal trend from 1947 to 1968 (Table 2). A similar trend has held for hardwood lumber production.

About three-fourths of all lumber (74 percent in 1962) is used in construction. Manufacturing uses (furniture, sports equipment, musical instruments, boats, toys, games, trunks, hand tools, pencils, caskets, blinds and shades, shoe lasts, commercial equipment, industrial machinery, etc.) take 11 percent of the total. Shipping and handling materials take 12 percent. The remaining 3 percent of the lumber output goes into a miscellany of uses, principally "do-it-yourself" projects.

#### Veneer Logs

Total veneer log production has trended upward steeply and consistently. From 275 million cubic feet in 1947, production rose to 1,135 million cubic feet in 1968.

The sharp upward trend in veneer log production reflects mainly the increase in demand for softwood plywood. Softwood veneer log production rose from 751 million board feet in 1947 to 6,070 million in 1968, an increase of more than 700 percent (Table 3). Hardwood veneer and plywood demand have also increased substantially, but the increased demand has been met by imports. Hardwood veneer log production in the United States reflects a horizontal trend; production totaled 819 million board feet in 1947, 865 million in 1968.

#### Pulpwood

Pulpwood remains the basic fiber source for a great variety of papers (book, fine, coarse and industrial, sanitary and tissue, and construction papers and newsprint) and boards (container, bending, building, and other boards). Pulpwood is also used for cellophane, rayon, photographic film and similar products. Use of pulp and paper products has increased steadily on a per capita as well as total basis.

Pulpwood production increased strikingly from 1,370 million cubic feet in 1947 to 3,155 million in 1968, an

Table 2.--Lumber Production in the United States, by Region, 1947-1968<sup>a/</sup>  
(Billion board feet)

Year	United States			North			South			West	
	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	<sup>b/</sup>
1947	35.4	28.0	7.4	5.4	2.0	3.4	13.6	9.6	4.0	16.3	
1948	37.0	29.6	7.4	6.0	2.6	3.4	13.2	9.2	4.0	17.8	
1949	32.2	26.5	5.7	4.1	1.5	2.6	11.6	8.5	3.1	16.5	
1950	38.0	30.6	7.4	4.9	2.0	3.0	14.6	10.2	4.4	18.6	
1951	37.2	29.5	7.7	5.0	1.7	3.3	13.3	8.9	4.4	18.9	
1952	37.5	30.2	7.2	4.1	1.4	2.7	13.7	9.2	4.5	19.7	
1953	36.7	29.6	7.2	5.0	1.5	3.5	11.8	8.1	3.7	19.9	
1954	36.4	29.3	7.1	4.6	1.7	3.0	11.7	7.7	4.1	20.0	
1955	37.4	29.8	7.6	4.5	1.5	3.0	12.2	7.7	4.5	20.7	
1956	38.2	30.2	8.0	5.1	1.6	3.4	12.7	8.2	4.5	20.5	
1957	32.9	27.1	5.8	4.1	1.8	2.2	10.3	6.7	3.5	18.6	
1958	33.4	27.4	6.0	3.9	1.4	2.5	9.8	6.4	3.4	19.7	
1959	37.2	30.5	6.7	4.2	1.5	2.7	11.0	7.0	3.9	22.0	
1960	32.9	26.7	6.3	3.9	1.2	2.7	9.3	5.9	3.4	19.6	
1961	32.0	26.1	6.0	3.7	1.2	2.5	9.1	5.8	3.4	19.2	
1962	33.2	26.8	6.4	3.9	1.2	2.7	9.5	5.9	3.6	19.9	
1963	34.7	27.6	7.2	4.2	1.3	2.9	10.2	6.1	4.1	20.3	
1964	36.6	29.3	7.3	4.4	1.1	3.2	10.5	6.6	3.9	21.7	
1965 <sup>c/</sup>	36.8	29.3	7.5	4.4	1.1	3.3	10.8	6.8	4.0	21.6	
1966 <sup>c/</sup>	36.5	28.8	7.7	4.5	1.1	3.4	10.8	6.7	4.1	21.1	
1967 <sup>c/</sup>	34.6	27.4	7.2	4.4	1.1	3.2	10.5	6.8	3.8	19.7	
1968 <sup>c/</sup>	36.5	29.8	6.7	4.1	1.2	2.9	10.9	7.3	3.6	21.5	

<sup>a/</sup> Data may not add to totals because of rounding.

<sup>b/</sup> Includes small volumes of western hardwoods--about 0.2 billion board feet in recent years.

<sup>c/</sup> Preliminary estimates.

Source: Data for 1947-49 from (5); data for 1950-68 from (6).



Table 3.--Veneer Log Production in the United States,<sup>a/</sup>  
1947-1968  
(Million board feet)

Year	All Species	Softwood	Hardwood
1947	1,570	751	819
1948	b/		
1949	b/		
1950	b/		
1951	2,271	1,232	1,039
1952	2,537	1,548	989
1953	2,815	1,861	954
1954	2,846	1,978	868
1955	3,433	2,431	1,002
1956	3,513	2,493	1,020
1957	3,332	2,455	877
1958	3,713	2,884	829
1959	4,350	3,488	862
1960	4,276	3,446	830
1961	4,628	3,836	792
1962	4,854	4,068	786
1963	5,308	4,530	778
1964	5,845	5,005	840
1965	6,275	5,425	850
1966	6,330	5,525	805
1967 <sup>c/</sup>	6,350	5,500	850
1968 <sup>c/</sup>	6,935	6,070	865

<sup>a/</sup>Includes small volumes of imported logs.

<sup>b/</sup>Data not available.

<sup>c/</sup>Preliminary estimates.

Source: Data for 1947 from (5); data for 1951-1968 from (6).

increase of 130 percent. From 13 percent of total log production in 1947, pulpwood output increased to 27 percent of the total in 1968.

Statistics on pulpwood roundwood production increasingly understate the volume of wood used in pulp manufacture. Wood chips used in 1950 totaled 1.3 million cords, or 6 percent of total domestic pulpwood production. In 1968, 16.3 million cords of chips were used (28 percent of total domestic pulpwood production). Most of the chips are produced from slabs, edgings, veneer cores, and other coarse residues of wood-using mills. However, a growing proportion of the chips received by pulp mills, especially in the South, is being produced from roundwood at chipping installations.

Total pulpwood production, including wood chips, is shown in Table 4. Both softwood and hardwood species have been used increasingly. Softwood production moved from 16 million cords in 1947 to 57.3 million in 1968; hardwood production from 2.5 million cords to 13.9. Hardwoods have gained in relative use from 14 percent of total production in 1947 to 24 percent in 1968. Soft-textured species, such as gum, aspen, yellowpoplar, and cottonwood, account for most of the hardwood cut. But the use of dense woods such as oak has been rising rapidly. Broadening the hardwood species base for pulp manufacture has greatly increased the timber resource available to the pulp and paper industry.

#### Other Industrial Timber

Miscellaneous industrial log products, a category including cooperage bolts, piling, poles, posts, mine timbers, hewn ties, box bolts, shingle bolts, excelsior bolts, turnery bolts, and chemical wood, have had a mixed record in production. Some products have increased in use; most have declined.

In overall terms, the trend of production<sup>1/</sup> is down from 940 million cubic feet in 1947 to 500 million in 1968. However, stability in the volume of production has become apparent in recent years. Production dropped steadily from 1947 to 1960, but since 1960 the trend has been almost horizontal.

<sup>1/</sup>Production is considered to be equivalent to consumption.



Table 4.--Pulpwood Production in the United States, by Region,  
1947-1968<sup>a/</sup>

(Million cords)

Year	United States			North			South			West <sup>b/</sup>
	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total
1947	18.5	16.0	2.5	5.6	4.3	1.3	9.3	8.1	1.2	3.6
1948	20.0	17.5	2.5	5.4	4.2	1.2	11.4	10.1	1.3	3.3
1949	17.6	15.3	2.3	4.6	3.3	1.3	9.9	8.9	1.0	3.1
1950	20.7	17.8	2.9	5.0	3.3	1.7	12.4	11.2	1.2	3.3
1951	25.1	21.3	3.8	6.3	4.1	2.2	14.1	12.5	1.6	4.7
1952	25.0	21.4	3.6	6.0	4.1	1.9	14.6	12.8	1.8	4.5
1953	26.3	22.2	4.2	5.4	3.2	2.2	17.2	14.1	2.0	4.7
1954	27.0	22.2	4.8	5.5	2.9	2.6	16.4	14.2	2.2	5.1
1955	30.9	25.6	5.3	6.5	3.9	2.6	18.4	15.7	2.6	6.0
1956	35.2	29.1	6.1	7.4	4.4	3.0	20.3	17.4	2.9	7.5
1957	34.4	28.2	6.2	7.3	4.3	3.0	19.8	16.8	3.0	7.4
1958	33.2	27.3	5.9	6.2	3.6	2.6	20.2	17.1	3.1	6.8
1959	36.7	29.1	7.6	6.6	3.3	3.3	22.8	18.7	4.0	7.4
1960	40.0	31.5	8.5	7.9	4.2	3.7	23.6	19.1	4.5	8.5
1961	40.3	31.5	8.8	7.2	3.6	3.6	24.2	19.4	4.9	8.9
1962	42.8	33.0	9.8	7.8	4.0	3.8	25.6	20.0	5.6	9.4
1963	44.7	34.2	10.5	8.0	3.9	4.1	26.6	20.7	5.9	10.1
1964	49.5	38.4	11.1	8.8	3.9	4.8	28.8	22.5	6.4	c/
1965	52.0	39.9	12.1	8.8	4.2	4.6	30.8	23.8	7.0	12.5
1966	55.5	41.9	13.6	10.0	4.6	5.4	33.1	25.4	7.7	12.5
1967 <sup>d/</sup>	55.1	41.6	13.5	9.9	4.6	5.4	33.7	25.9	7.7	11.6
1968 <sup>d/</sup>	57.3	43.4	13.9	10.4	4.8	5.6	34.9	27.0	7.9	12.0

<sup>a/</sup> Data may not add to totals because of rounding.

<sup>b/</sup> Softwood mainly. Includes small volumes of hardwoods, increasing gradually to 0.5 million cords in recent years.

<sup>c/</sup> Not available.

<sup>d/</sup> Preliminary estimates.

Source: Data for 1947-1949 from (5); data for 1950-1968 from (6).

### Fuelwood

Fuelwood cut from roundwood is used almost entirely for domestic heating and cooking. Fuelwood from plant by-products such as slabs and edgings (about 45 percent of total fuelwood use) is used both for domestic purposes and for steam power in wood-processing plants. Both categories of fuelwood use have declined.

Production of fuelwood cut from roundwood declined rapidly from 2,685 million cubic feet in 1947 to 1,125 million in 1962. Since 1962, the decline has slowed considerably, but it has continued. Production was down to 970 million cubic feet in 1968.

### Regional Trends in Production

Table 5 shows a detailed breakdown of roundwood production by region and product for the year 1962. Industrial roundwood production is distributed by region as follows: Northeast, 8 percent; North Central, 8 percent; South, 39 percent; Rocky Mountain, 7 percent; and Pacific, 38 percent.

Sawlog production, more than 80 percent of which is softwood, is concentrated in the Pacific region. In 1962, this one region provided some 57 percent of all the softwood sawlogs produced and 45 percent of total sawlogs. The South produces 32 percent of the total in a softwood-hardwood ratio of nearly 2 to 1. Eighty percent of total veneer log production, virtually all softwood, is produced in the Pacific region. In pulpwood production, the South is the dominant region, producing in 1962 some 62 percent of the total nation's pulpwood (65 percent of the softwood and 54 percent of the hardwood). Miscellaneous industrial roundwood production is concentrated in eastern United States--44 percent in the South and 38 percent in the North. Southern production of miscellaneous industrial roundwood is 58 percent softwood, but in the North production is 78 percent hardwood.

Regional trends can be traced only for lumber (which is sufficiently close to sawlog production to be considered an equivalent product) and pulpwood. In total lumber production, which exhibits a horizontal trend from 1947 to 1968, regional trends vary (Table 2). Lumber production in the North, nearly three-fourths hardwood, has tended to hold steady since 1957, but has declined slightly from 5.4 billion board feet in 1947 to 4.1 billion in 1968. Lumber production in the South declined from 13.6 billion board feet in 1947 to 10.3 billion in 1957; since 1957, the trend



Table 5.--Estimated Volume of Domestic Roundwood Production in the United States, by Major Product and Region, 1962<sup>a/</sup>  
(Million cubic feet)

Product and Region	United States	North-east	North Central	South	Rocky Mtn.	Pacific
Sawlogs:						
Softwood	4,224	142	50	1,097	541	2,394
Hardwood	1,047	171	275	579	2	19
Total	5,271	313	325	1,676	543	2,413
Veneer Logs:						
Softwood	708			3	19	687
Hardwood	149	22	18	109		
Total	857	22	18	112	19	687
Pulpwood:						
Softwood	1,886	196	114	1,231	20	324
Hardwood	717	118	168	390		41
Total	2,603	314	282	1,621	20	365
Misc.						
Industrial:						
Softwood	239	24	16	120	18	60
Hardwood	226	54	85	86	2	
Total	465	78	100	206	20	60
Fuelwood:						
Softwood	208	27	6	118	16	41
Hardwood	916	200	267	443	2	4
Total	1,124	227	273	561	18	45
All Roundwood:						
Softwood	7,264	389	185	2,570	615	3,506
Hardwood	3,056	565	813	1,608	6	64
Total	10,320	954	998	4,177	621	3,570

<sup>a/</sup> Columns may not add to totals because of rounding.

Source: Data from (5).

has been horizontal. In the West, the trend has been up from 16.3 billion board feet in 1947 to 21.5 billion in 1968.

Pulpwood production has expanded rapidly in all regions (Table 4), but at differential rates. In 1947, the North accounted for 30 percent of the total production; the South, 50 percent; and the West, 20 percent. By 1968, the North's share was down to 18 percent and the South's share was up to 61 percent; the West remained essentially even at 21 percent.

#### Exports and Imports

Net imports of industrial timber products in roundwood equivalents increased from 795 million cubic feet in 1947 to 1,560 million in 1968 (Table 6), a much more rapid rate of increase than is evident for apparent consumption of industrial roundwood (from 8,815 million cubic feet in 1947 to 12,070 million cubic feet in 1968). However, net imports increased from 9 percent of consumption in 1947 to 14 percent in 1950; thereafter, it has held steady at about 13 percent, varying only between 12 and 14 percent.

Log imports, estimated at 77 million board feet in 1967, were only slightly lower than the average of the last five years, but considerably below the 230 million board-foot average of 1950-1954. Over half of the 1967 imports originated in Canada, chiefly softwood species. Most other log imports are tropical hardwoods from South America and Africa. Log imports are used in the manufacture of lumber, veneer, plywood and wood pulp, and are reflected in the production statistics for these products.

Log exports reached 2.0 billion board feet in 1967 and may have attained 2.6 billion in 1968. The growth curve is striking--48 million board feet in 1950, 522 million in 1962, 1.2 billion in 1965. Some 95 percent of the export is softwood, mostly from western Washington and Oregon. Japan, the destination of 80 percent of the exports in 1967, has been the principal market for the rapidly rising log exports.

Despite the preponderance of log exports over imports, the United States is a net importer in most major timber categories. Lumber exports, mainly softwoods to worldwide markets, declined from 1.2 billion board feet in 1947 to 0.5 billion in 1948, then recovered slowly to 1.2 billion in 1968. Lumber imports, over 90 percent softwood and 95 percent from Canada, have expanded steadily from 1.3 billion board feet in 1947 to 5.8 billion in 1968. Thus, the net balance shows a large and increasing import of lumber.



Table 6.--Net Imports of Timber Products in Roundwood Equivalents, by Major Product, 1947-1968 (Million cubic feet)

Year	All Products	Sawlog <sup>a/</sup> Products	Veneer Log <sup>b/</sup> Products	Pulpwood <sup>c/</sup> Products
1947	795	5 <sup>d/</sup>	5 <sup>d/</sup>	805
1948	1,055	190	...	865
1949	915	140	...	775
1950	1,350	455	5	890
1951	1,185	235	5	945
1952	1,140	275	5	860
1953	1,215	330	15	870
1954	1,180	365	25	790
1955	1,265	430	35	800
1956	1,350	420	40	890
1957	1,170	335	45	790
1958	1,210	415	50	745
1959	1,380	515	70	795
1960	1,255	480	60	715
1961	1,310	545	65	700
1962	1,485	645	85	755
1963	1,500	695	95	710
1964	1,500	665	110	725
1965	1,580	670	120	790
1966	1,635	650	140	845
1967	1,490	625	135	730
1968	1,560	730	205	625

<sup>a/</sup>Net imports of lumber converted to cubic feet roundwood.

<sup>b/</sup>Net imports of veneer and plywood converted to board feet log scale, and then to cubic feet roundwood.

<sup>c/</sup>Net pulpwood imports and the pulpwood equivalent of the net wood pulp and paper and board imports.

<sup>d/</sup>Net exports.

Source: Data for 1947-49 from (5); data for 1950-68 from (6).

Net imports of pulpwood (considering all pulpwood and pulp, paper and board products in pulpwood equivalents) held a slightly downward trend at a high level throughout the period 1947-1967, averaging 849 million cubic feet annually during 1947-1956 and 757 million during 1957-1966. In 1968, the net import dropped to 625 million cubic feet. Imports have trended upward (from 12 million cords in 1950 to 16 million cords in 1968), but exports have moved up more rapidly (from 0.6 million cords in 1950 to 8 million cords in 1968). The great bulk of the imports is from Canada. Most exports move to Western Europe and the Far East, mainly Japan.

Net imports in veneer and plywood (considering these products in roundwood equivalents) reflect a steadily increasing trend from 5 million cubic feet in 1947 to 205 million in 1968. Softwood plywood trade, both in exports and imports, remains small. A negligible amount of hardwood plywood is exported, but imports have jumped from 0.1 billion square feet in 1950 to 3.9 billion in 1968. Similarly, hardwood veneer exports have been limited (although increasing up to 0.2 billion square feet in 1967), but imports have jumped from 0.1 billion square feet in 1947 to 2.0 billion in 1967. Most of the increase in hardwood plywood imports has consisted of lauans and other tropical hardwoods mainly from Japan, Korea, Taiwan, and the Philippines, although imports of birch and maple from Canada have also risen substantially. Hardwood veneer imports are mainly tropical species, chiefly from the Philippines, Africa, and Southeast Asia, and birch and maple from Canada.

#### Round Timber Consumption

Consumption is roughly equivalent to production plus net imports. Domestic consumption can therefore be approximated by adding net imports to the production data summarized in the preceding tables. A general summary of the consumption of timber products for the period 1947-1968 is shown in Table 7.

For all timber products combined, the trend in consumption is similar to that in production--horizontal from 1947 to 1963, then a 9-percent rise to 1968. Net imports of all timber products combined did not vary sufficiently over this time period to affect general production-consumption relationships.

In sawlog products, a trend of rising net imports, superimposed on a horizontal trend of production, is sufficient to give a slight upward tilt to the trend of consumption.



Table 7.--Consumption of Timber Products in the United States in Roundwood Equivalents by Major Product, 1947-1968

(Million cubic feet)

Year	All Timber Products	Industrial Roundwood					Fuel-wood
		Total	Sawlogs	Veneer Logs	Pulp-wood	Other	
1947	11,500	8,815	5,495	265	2,115	940	2,685
1948	12,000	9,335	5,940	295	2,250	850	2,665
1949	11,130	8,310	5,145	320	2,100	745	2,820
1950	12,225	9,955	6,360	350	2,475	770	2,270
1951	12,055	9,825	6,020	400	2,675	730	2,230
1952	11,845	9,835	6,095	440	2,600	700	2,010
1953	11,925	10,005	6,040	490	2,800	675	1,920
1954	11,830	9,995	6,015	505	2,820	655	1,835
1955	12,230	10,485	6,215	615	3,025	630	1,745
1956	12,490	10,835	6,335	630	3,265	605	1,655
1957	11,300	9,735	5,435	605	3,115	580	1,565
1958	11,215	9,735	5,575	665	2,935	560	1,480
1959	12,160	10,770	6,260	790	3,185	535	1,390
1960	11,360	10,060	5,560	765	3,225	510	1,300
1961	11,230	10,015	5,485	825	3,215	490	1,215
1962	11,590	10,465	5,765	880	3,355	465	1,125
1963	11,970	10,860	6,050	965	3,385	460	1,110
1964	12,640	11,550	6,305	1,070	3,635	540	1,090
1965 <sup>a/</sup>	12,855	11,795	6,345	1,150	3,800	500	1,060
1966 <sup>a/</sup>	13,005	11,975	6,280	1,175	4,020	500	1,030
1967 <sup>a/</sup>	12,480	11,480	6,000	1,175	3,805	500	1,000
1968 <sup>a/</sup>	13,040	12,070	6,405	1,340	3,825	500	970

<sup>a/</sup> Preliminary estimates.

Source: Data for 1947-1949 from (5); data for 1950-1968 from (6).

In veneer log products, the steep upward trend in consumption is sharper than that of production; hardwood production has followed a horizontal trend, but net imports of hardwood veneer and plywood increased from 0.1 billion square feet in 1950 to 3.7 billion in 1968. In pulpwood products, due to a slightly downward trend in net imports of large volume, the upward trend in consumption is at a lower rate than for production; consumption increased 81 percent from 1947 to 1968, in contrast to a production increase of 130 percent.

#### Projections of United States Timber Production

The projections of timber production adopted in this section are those developed in the Nathan Report (4). Consumption was projected to 1980 and 2000; aggregate consumption figures were developed for lumber, veneer and plywood, wood pulp, and other (fuelwood and miscellaneous industrial uses) by analyzing separately the outlook for each of the major end products. Parallel projections were made for net imports, and projections of production were derived by subtracting net imports from consumption.

#### Basis for Projections

Nathan Report projections were based on analyses by the U. S. Forest Service (7, 8). The statistics used in the Forest Service studies were revised to accord with current findings, some of the procedures used by the Forest Service were modified, and underlying assumptions about population, number of households, gross national product and disposable personal income were adjusted to agree with newer projections of economic aggregates. In relation to price, the Nathan Report assumes that price-induced substitutions are generally reflected in the 1948-1965 trends and that extension of these trends implies a continuation of past rates of substitutions. The implication is that price-induced substitution will be important in the future for lumber, less important for plywood and veneer, and least important for woodpulp products. In regard to nonprice factors, the Nathan Report recognizes trends in technological change, particularly those trends in construction methods which will reduce the demand for lumber and, to a lesser extent, the demand for plywood.

#### Other Study Projections

Other study projections were examined and rejected for use in this report. The Forest Service's report on Timber



Trends rests on projections of population, gross national product, and other economic aggregates which are no longer acceptable. The Forest Service assumption about price--that future prices of timber products will be more or less constant in relation to prices of competing materials and that, therefore, price-induced substitution of other materials will be limited--is also less acceptable than the price assumptions of the Nathan Report. Finally, the Forest Service did not adequately recognize technological changes in construction pointing to replacement of lumber by substitute products.

Landsberg et al (2) projected roundwood consumption from 1960 to 1980 and 2000. This study also suffers in that its underlying assumptions about economic aggregates, acceptable when made, are no longer acceptable. More fundamental weaknesses rest in its ignoring of price effects and technological changes. Pulp and paper consumption was projected upward at too low a rate, as the record of consumption to date shows clearly, and the nearly three-fold increase projected for lumber consumption has no basis that can be recognized in recent trends.

#### Projections of Consumption

Projections of timber consumption in roundwood equivalents are summarized in Table 8. The stress is on the medium projections since these are the most likely results of the projected variables, but high and low projections are also shown to define the plausible range of expectations.

In lumber products, the medium projections suggest very little change from 1968 levels of consumption, both in softwoods and hardwoods. Total lumber consumption is projected almost horizontally in accord with established trends from 6.4 billion cubic feet in 1968 to 6.2 billion in 2000. Medium projections for veneer and plywood products continue the well-established upward trends in both softwood and hardwood consumption. Softwood veneer and plywood is projected upward some 160 percent from 1968 to 2000; hardwood is projected upward 100 percent. In pulp and paper products, an overall 245-percent increase is projected; the percentage increase is larger for hardwoods, but the volume increase is greater for softwoods. Projections for miscellaneous products reflect an overall increase to 1980, then a decline to 2000 at a level slightly below 1968 consumption. A decrease in hardwood consumption (mainly fuelwood) is partially balanced by an increase in softwood consumption (mainly miscellaneous industrial products).

To summarize for all products combined, consumption is projected from 13 billion cubic feet in 1968 to 23.8

Table 8.--Consumption of Timber Products in the United States, 1968 and Projected to 1980 and 2000<sup>a/</sup>

Timber Products	1968	1980			2000		
		Low	Medium	High	Low	Medium	High
		(Billion cubic feet, roundwood equivalent)					
Lumber:							
Softwood	5.2 <sup>b/</sup>	5.0	5.2	5.3	3.7	5.0	5.1
Hardwood	1.2 <sup>b/</sup>	1.2	1.3	1.3	0.9	1.2	1.3
Total	6.4	6.2	6.5	6.7	4.6	6.2	6.4
Veneer and Plywood:							
Softwood	1.1 <sup>b/</sup>	1.7	1.8	1.8	1.9	2.7	2.9
Hardwood	0.2 <sup>b/</sup>	0.1	0.2	0.3	0.3	0.4	0.4
Total	1.3	1.9	2.0	2.1	2.2	3.1	3.3
Pulp and Paper:							
Softwood	3.0 <sup>b/</sup>	5.4	5.7	6.2	7.8	8.5	9.4
Hardwood	0.8 <sup>b/</sup>	2.6	2.8	3.0	4.2	4.6	5.1
Total	3.8	8.0	8.5	9.2	12.0	13.1	14.5
Other: <sup>c</sup>							
Softwood	0.3 <sup>b/</sup>	0.7	0.7	0.7	0.5	0.5	0.5
Hardwood	1.2 <sup>b/</sup>	1.2	1.2	1.2	0.9	0.9	0.9
Total	1.5	1.9	1.9	1.9	1.4	1.4	1.4
All Products:							
Softwood	9.6	12.8	13.4	14.1	13.9	16.7	17.9
Hardwood	3.4	5.2	5.5	6.8	6.3	7.1	7.7
Total	13.0	18.0	18.9	19.9	20.2	23.8	25.6

Source: Projections from [4]. Product totals for 1968 from [6].

<sup>a/</sup> Figures may not add to totals because of rounding.

<sup>b/</sup> Estimated.

<sup>c/</sup> Fuelwood and miscellaneous industrial uses.



billion in 2000. The relative increases are 74 percent for softwoods, 109 percent for hardwoods.

#### Projections of Net Imports

Projected net imports subtracted from consumption indicate the levels of domestic production that may be expected. The Nathan Report simply records projected consumption and production, but by subtracting production from consumption it is possible to note the net import assumptions implicit in the calculations. Projections of net imports are summarized in Table 9.

Medium projections of net imports show an increase for sawlog products from 0.5 billion cubic feet in 1968 to 0.6 in 1980 and 2000. In veneer log products, the projected increase is from 0.1 billion cubic feet in 1968 to 0.6 billion in 2000; all of the increase is projected in softwood species. In pulpwood products, net imports of 0.6 billion cubic feet in 1968 are projected to 1.6 billion in 2000; the increase is mostly in softwood species. Overall, the projected increase in net imports of timber products is from 1.2 billion to 2.8 billion cubic feet. Net imports represent 12 percent of consumption in 1968, 12 percent in 2000.

Both exports and imports are particularly difficult to forecast. Political considerations, which are difficult to predict in the long run, have a strong influence on trade policies. Economic considerations, including unpredictable rates of exchange, balance of payments, tariff regulations and shipping regulations, create many imponderables difficult to evaluate realistically. Detailed appraisal of the many subjective factors involved could lead to greatly differing projections of net imports. Under the circumstances, the Nathan Report approach of projecting net imports to represent 12 percent of consumption (essentially a continuation of the stable rate from 1950 to 1968) is considered acceptable for purposes of this report.

#### Projections of Production

Projections of domestic production (round timber equivalents) are shown in Table 10. Total timber is projected from 11.8 billion cubic feet in 1968 to medium estimates of 17.1 billion in 1980 and 21 billion in 2000. The increase for the 32-year period is 78 percent. The increase projected for softwood species is 65 percent; for hardwood species about 110 percent. Despite the differential rates of increase

Table 9.--United States Net Imports of Timber Products, 1968, and Under Projections of Consumption and Production to 1980 and 2000<sup>a/</sup>

Timber Products	1968	1980			2000		
		Low	Medium	High	Low	Medium	High
(Billion cubic feet, roundwood equivalent)							
Lumber:							
Softwood	0.4	0.6	0.5	0.4	0.3	0.5	0.5
Hardwood	0.1	<u>b/</u>	0.1	0.1	0.1	0.1	0.1
Total	0.5	0.6	0.6	0.6	0.4	0.6	0.6
Veneer and Plywood:							
Softwood	<u>b/</u>	0.3	0.3	0.2	0.3	0.5	0.5
Hardwood	0.1	-0.1	<u>b/</u>	0.1	0.1	0.1	0.1
Total	0.1	0.3	0.3	0.3	0.4	0.6	0.6
Pulp and Paper:							
Softwood	0.6	0.6	0.6	0.7	1.5	1.5	1.7
Hardwood	<u>b/</u>	0.3	0.3	0.3	<u>b/</u>	0.1	0.1
Total	0.6	0.9	0.9	1.0	1.5	1.6	1.8
All Products:							
Softwood	1.0	1.5	1.4	1.3	2.1	2.5	2.7
Hardwood	0.2	0.3	0.4	0.5	0.2	0.3	0.3
Total	1.2	1.8	1.8	1.9	2.3	2.8	3.0

Source: Derived from Tables 8 and 10.

a/ Figures may not add to totals because of rounding.

b/ Negligible.



Table 10.--Domestic Production of Timber Products in the United States, 1968, and Projected to 1980 and 2000.

(Billion cubic feet, roundwood equivalent)

Timber Products	1968	1980			2000		
		Low	Medium	High	Low	Medium	High
Sawlogs:							
Softwood	4.8 <sup>a/</sup>	4.4	4.7	4.9	3.4	4.5	4.6
Hardwood	1.1 <sup>a/</sup>	1.2	1.2	1.2	0.8	1.1	1.2
Total	5.9	5.6	5.9	6.1	4.2	5.6	5.8
Veneer							
Logs:							
Softwood	1.1 <sup>a/</sup>	1.4	1.5	1.6	1.6	2.2	2.4
Hardwood	0.1 <sup>a/</sup>	0.2	0.2	0.2	0.2	0.3	0.3
Total	1.2	1.6	1.7	1.8	1.8	2.5	2.7
Pulpwood:							
Softwood	2.4 <sup>a/</sup>	4.8	5.1	5.5	6.3	7.0	7.7
Hardwood	0.8 <sup>a/</sup>	2.3	2.5	2.7	4.2	4.5	5.0
Total	3.2	7.1	7.6	8.2	10.5	11.5	12.7
Other: b/							
Softwood	0.3 <sup>a/</sup>	0.7	0.7	0.7	0.5	0.5	0.5
Hardwood	1.2 <sup>a/</sup>	1.2	1.2	1.2	0.9	0.9	0.9
Total	1.5	1.9	1.9	1.9	1.4	1.4	1.4
All Products:							
Softwood	8.6	11.3	12.0	12.7	11.8	14.2	15.2
Hardwood	3.2	4.9	5.1	5.3	6.1	6.8	7.4
Total	11.8	16.2	17.1	18.0	17.9	21.0	22.6

<sup>a/</sup> Estimated.

<sup>b/</sup> Fuelwood and miscellaneous industrial uses.

Source: Projections from (4); data for 1968 from (6).

in the species groups, the medium projection for softwood is to 14.2 billion cubic feet, more than twice the projected figure for hardwood.

In sawlogs, production is projected slightly downward-- 6 percent downward in softwoods, horizontally in hardwoods. Veneer log production is projected upward in the medium estimates about 110 percent--100 percent in softwoods, 200 percent in hardwoods. In pulpwood, the medium projection is from 3.2 billion cubic feet (75 percent softwood) to 11.5 billion cubic feet (61 percent softwood). The medium projection for miscellaneous products shows an increase to 1980, then a decline to 1.4 billion cubic feet in 2000, slightly below the 1968 level of production.

Aside from the overall increase in projected wood production, which has considerable bearing on public land policy, it is highly pertinent to note the projections for different wood products. The public lands have three-fourths of the nation's sawtimber inventory, and the publicly owned timber inventory plays an increasingly important role in meeting demand for softwood sawtimber. The demand for softwood sawtimber products is essentially a demand for softwood sawlogs and veneer logs. In 1968, the production of such products totaled 5.9 billion cubic feet. The projection is to 6.2 billion cubic feet in 1980 (an increase of 5 percent) and 6.7 billion in 2000 (an increase of 14 percent). This is a much lower production projection than applies to all timber, a consequence of the dominant influence of pulpwood products. Pulpwood, available from small timber sizes and increasingly available from all species, accounts for the bulk of the timber-production increase projected to 1980 and 2000. By the year 2000, pulpwood will account for 55 percent of the all-timber medium projection of timber production.

#### Timber Production on the Public Lands

#### The Public Timber Resource

Commercial forest land in the United States, defined as forest land capable of producing crops of industrial wood in excess of 20 cubic feet per acre of annual growth and not withdrawn from timber utilization by statute or administrative regulation, totals 510 million acres (Table 11). Twenty-two percent of this area is in Federal ownership; another 6 percent is in state and local public ownership. Federal ownership accounts for 2 percent of the commercial forest in the Northeast, 12 percent in the North Central region, 7 percent in the South, and 65 percent in the West.



Table 11.--Commercial Forest Land in the United States, by Ownership, 1968<sup>a</sup>  
(Million acres)

Region	All Ownership	Federal	Other Public	Private
Northeast	62.9	1.5	4.9	56.5
North Central	86.2	10.4	14.6	61.2
South	226.8	15.9	3.4	207.4
West:	134.7	85.6	6.3	42.9
Pacific	(70.4)	(38.3)	(3.9)	(28.1)
Mountain	(64.3)	(47.4)	(2.4)	(14.8)
United States	510.5	113.5	29.2	368.0

<sup>a</sup>/ Columns may not add to totals because of rounding.

Source: Data from (1).

The Forest Service administers 96.8 million acres, or 85 percent of the total Federal commercial forest. The Bureau of Land Management administers a major share of the remaining Federal commercial forest, although there is some uncertainty about the area involved.<sup>1</sup> Other Federal agencies with commercial forest land include the Department of Defense, with 2.2 million acres, and the National Wildlife Refuge System, with 0.6 million acres.

Although public ownership (including Federal, state and local public ownership) is limited to 28 percent of the commercial forest, the timber volume of 298 billion cubic feet on this land represents 42 percent of the nation's inventory of timber volume (Table 12). The high concentration of timber volume in the West, particularly on the Pacific Coast, is notable. Western timber is nearly all softwood, and a large portion of it is on public lands.

The importance of public ownership of timber resources is more apparent in Table 13. Sawtimber volume, estimated at 2,525 billion board feet, is 56 percent publicly owned. Two-thirds of the softwood sawtimber is publicly owned. More than 70 percent of the nation's sawtimber resource is located in the West, and nearly three-fourths of this is in public ownership.

About 80 percent of all the publicly owned timber--both total growing stock and sawtimber--is in the national forests. Most of the remaining timber volume in Federal ownership is under the administration of the Bureau of Land Management. Thus, an analysis of the timber resource on the Federal lands can be limited essentially to the national forests and Bureau of Land Management lands.

#### Trends in Timber Production

Timber production on the Federal lands is concentrated on the national forests. The Forest Service share of the total Federal timber cut was close to 90 percent throughout the period 1947-68 (Table 14). Nearly all of the remaining cut on Federal lands is under the administration of the Bureau of Land Management. Production from all other Federal lands has not exceeded 50 million cubic feet in any year.

<sup>1</sup>/ The BLM Defines commercial forest land as land in its "intensive management areas" having the potential to efficiently produce timber products on a sustained yield basis. By its standards, the BLM classifies 35 million acres in Alaska under its administration and 4 million acres in the West as commercial forest land. The classification which is the basis for Table 11 considers 5.3 million acres of BLM lands in the West as commercial forest and only 0.3 million acres in Alaska.



Table 12.--Volume of Growing Stock on Commercial Forest Land in the United States, by Ownership, 1968<sup>a/</sup>  
(Billion cubic feet)

Region	All Ownership			Public			Private		
	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood
Northeast	64	21	43	7	1	6	56	20	36
North Central	51	10	41	15	6	9	37	4	33
South	155	65	90	18	9	9	138	56	81
West:	356	339	17	258	250	8	98	89	9
Pacific	(259)	(247)	(12)	(178)	(173)	(4)	(81)	(73)	(7)
Mountain	(98)	(92)	(5)	(80)	(77)	(4)	(17)	(16)	(1)
United States	626	435	192	298	265	32	329	169	159

<sup>a/</sup> Columns may not add to totals because of rounding.

Source: Data from (1).

Table 13.--Volume of Sawtimber on Commercial Forest Land in the United States, by Ownership, 1968<sup>a/</sup>  
(Billion board feet)

Region	All Ownership			Public			Private		
	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood
Northeast	114	41	73	12	2	10	101	39	63
North Central	126	23	102	26	12	14	100	11	89
South	474	232	242	58	34	23	416	198	218
West:	1811	1763	48	1326	1305	21	485	458	28
Pacific	(1397)	(1359)	(39)	(983)	(969)	(14)	(414)	(414)	(25)
Mountain	(415)	(405)	(9)	(343)	(336)	(6)	(72)	(69)	(3)
United States	2525	2059	465	1422	1354	68	1103	706	398

<sup>a/</sup> Columns may not add to totals because of rounding.

Source: Data from (1).



Table 14.--Production of Timber Products on the Federal Lands Compared with United States Production, 1947-68<sup>a</sup>

Year	United States	Federal		Total Federal <sup>b/</sup>	Federal as Percentage of U.S.
		Forest Service	BLM		
(Billion cubic feet)					
1947	10.8	0.8	0.1	0.9	8
1948	11.0	0.7	0.1	0.8	7
1949	10.2	0.8	0.1	0.9	9
1950	10.8	0.7	0.1	0.8	7
1951	11.0	1.0	0.1	1.1	10
1952	10.8	0.9	0.1	1.0	9
1953	10.7	1.0	0.1	1.1	10
1954	10.6	1.1	0.1	1.2	11
1955	10.9	1.3	0.1	1.4	13
1956	11.3	1.4	0.1	1.5	13
1957	10.2	1.4	0.1	1.5	15
1958	10.0	1.3	0.2	1.5	15
1959	10.8	1.7	0.2	1.9	18
1960	10.2	1.9	0.2	2.1	21
1961	9.9	1.7	0.2	1.9	19
1962	10.2	1.8	0.2	2.0	20
1963	10.6	2.0	0.2	2.2	21
1964	11.4	2.2	0.4	2.6	23
1965	11.5	2.3	0.3	2.6	23
1966	11.6	2.4	0.3	2.7	23
1967	11.3	2.2	0.3	2.5	22
1968	11.8	2.4	0.3	2.7	23

a/ Production data supplied by Federal agencies in board feet were adjusted as footnoted in Table 15, then converted to cubic feet on basis of 1,000 board feet equals 156 cubic feet in the West, 166 in the North, and 163 in the South.

b/ Production from lands of other Federal agencies less than 50 million cubic feet in any year and, therefore, negligible for reporting in this table.

The timber cut on Federal lands increased three-fold from 0.9 billion cubic feet in 1947 to 2.7 billion in 1968. The rate of increase was similar for the national forests and Bureau of Land Management (BLM) lands. Since United States timber production increased only slightly over the same time period, the Federal share of the total increased substantially--from 8 percent in 1947 to 23 percent in 1968.

Regional contrasts in production are evident in Table 15. Output on the national forests over the period 1947-1968 increased about 3-1/2 times in the Pacific Coast states, tripled in the Rocky Mountain states, and doubled both in the North and the South. Regional contrasts are more difficult to draw for Bureau of Land Management lands since only the Pacific Coast and Rocky Mountain regions are involved and nearly all of the production is confined to Pacific Coast states. The extensive public domain lands actually contribute little to the Bureau of Land Management cut. Well over 90 percent of the entire cut on Bureau of Land Management lands occurs on the revested Oregon and California lands and the reconveyed Coos Bay Wagon Road lands in western Oregon.

As of 1968, the Forest Service timber cut of all products was distributed by regions as follows:

66 percent	Pacific Coast
22 percent	Rocky Mountain
5 percent	North, and
7 percent	South

Although the cut increased in absolute amounts in all regions over the 1947-1968 period, the Pacific Coast share increased relatively, the Rocky Mountain share remained stable, and the North and South shares decreased.

Distribution of the 1966 Federal timber cut in sawlog, pulpwood, and veneer log units was estimated in the Banzhaf Report (1). Sawlogs accounted for 63 percent of the total volume reported; pulpwood, 25 percent; and veneer logs, 12 percent.



Table 15.--Estimated Production of Timber Products on Lands Administered by the Forest Service and Bureau of Land Management, by Region, 1947-68<sup>a</sup>

Year	Pacific Coast			Rocky Mtn.			North South		All Regions		
	USFS	BLM	Total	USFS	BLM	Total	b/	c/	USFS	BLM	Total
(Billion board feet)											
1947	2.9	0.6	3.5	1.2		1.2	0.4	0.5	5.0	0.6	5.6
1948	2.7	0.5	3.2	0.9		0.9	0.6	0.6	4.8	0.5	5.3
1949	2.9	0.4	3.3	0.8		0.8	0.6	0.6	4.9	0.4	5.3
1950	2.6	0.5	3.1	0.9		0.9	0.4	0.6	4.5	0.5	5.0
1951	3.8	0.6	4.4	1.2		1.2	0.5	0.6	6.1	0.6	6.7
1952	3.4	0.6	4.0	1.2		1.2	0.5	0.6	5.7	0.6	6.3
1953	4.2	0.8	5.0	1.4		1.4	0.5	0.6	6.7	0.8	7.5
1954	4.2	0.9	5.1	1.6		1.6	0.6	0.6	7.0	0.9	7.9
1955	4.8	0.9	5.7	1.9		1.9	0.6	0.8	8.1	0.9	9.0
1956	5.2	0.9	6.1	2.1		2.1	0.8	0.9	9.0	0.9	9.9
1957	5.3	0.9	6.2	2.1		2.1	0.8	0.9	9.1	0.9	10.0
1958	4.9	1.2	6.1	1.8		1.8	0.6	0.9	8.2	1.2	9.4
1959	6.9	1.2	8.1	2.1	0.1	2.2	0.8	1.0	10.8	1.3	12.1
1960	7.9	1.3	9.2	2.3	0.1	2.4	0.9	1.0	12.1	1.4	13.5
1961	6.9	1.0	7.9	2.3	0.1	2.4	0.6	1.0	10.8	1.1	11.9
1962	7.7	1.4	9.1	2.3	0.1	2.4	0.6	1.0	11.6	1.5	13.1
1963	8.4	1.4	9.8	2.9	0.1	3.0	0.6	1.0	12.9	1.5	14.4
1964	9.4	2.2	11.6	3.0	0.1	3.1	0.9	1.0	14.3	2.3	16.6
1965	9.6	2.0	11.6	3.0	0.1	3.1	0.9	1.0	14.6	2.1	16.7
1966	10.5	1.7	12.2	3.2	0.1	3.3	0.9	1.0	15.6	1.8	17.4
1967	8.8	1.8	10.6	3.2	0.1	3.3	1.0	1.0	14.0	1.9	15.9
1968	10.4	1.8	12.2	3.5	0.1	3.6	0.8	1.0	15.7	1.9	17.6

a/ Basic data supplied by agencies. Reported figures are based on local log rules which result in varying amounts of overrun, or output of products. Studies by agency personnel of this and other sources of reporting error suggest an output of products about 30 percent more than the reported timber cut. Therefore, all reported figures have been adjusted upward 30 percent in this table to more closely approximate the actual output of timber products on federal lands.

b/ Virtually all U. S. Forest Service.

c/ All U. S. Forest Service.

d/ All products reported in terms of board-foot measure.

# Projections of Timber Production on the Public Lands

## Straight-Line Projection of Trend

Straight-line projection of the 1947-1968 trends in production indicates that the Federal lands will yield 3.9 billion cubic feet of timber products in 1980 and 5.8 billion in the year 2000. These projections represent increases of 45 percent and 115 percent, respectively, above the 1968 level of output. On this basis, the Federal lands will contribute 23 percent of the projected national outputs of timber products in 1980 and 28 percent in the year 2000.

Under the assumption of straight-line projection, more than 90 percent of the total timber output of the Federal lands will continue to come from the national forests. National forest output is projected to 3.6 billion cubic feet in 1980 and 5.4 billion in 2000. The increase from the 1968 level of output is 50 percent to 1980, 126 percent to the year 2000. The national forest share of total United States timber production is projected from 20 percent in 1968 to 21 percent in 1980 and 26 percent in 2000.

## Projection Based on Current Level of Management

Substantial increases in yields of timber will be available from the Federal forests even without increasing the intensity of management. Unpublished Forest Service analyses indicate that if the 96 million acres of unreserved commercial forest in the national forest system remain available for timber production, then continuing the present level of management (current levels of regeneration treatment at the beginning of the rotation, road construction, timber sales administration activity, and protection from fire and pests) eventually will sustain a greatly increased annual harvest of timber. The assumption here is that continuation of the present level of road building to open up additional stands for cutting operations in conjunction with projected increases in the demand for timber products will result in economic accessibility of a total of 68 million acres of national forest land by the year 2000. These economically accessible acres will yield a sustainable harvest of 3.6 billion cubic feet annually under present levels of management.

If a similar analysis can be extended to other Federal lands, the sustainable annual harvest under current levels of management for all Federal lands is about 4.0 billion cubic feet.



#### Projection Based on Intensified Management

Marty and Newman (3) analyzed opportunities for timber management intensification on the national forests. Recognizing 61 region-type-site classes, the authors were able to present acreages for each region-type-site class and yields obtainable in each under assumptions of management intensity necessary to meet the predicted yields. Management intensification generally required additional regeneration treatment, weeding and precommercial thinning of young stands and a series of commercial thinnings preceding final harvest. Fire and pest protection were presumed to continue at current rates. Management costs were estimated for each management activity based on current cost experience. Prices of stumpage were projected on the basis of current national forest sales experience. Some species prices were projected upward, but Southern pine, Douglas fir, and eastern hardwood prices were projected at current levels. Finally, the comparative efficiency of management intensification was measured by a rate of return--the compound interest rate at which the added costs of intensification equate with the added stumpage values they generate.

The potential effect of management intensification is large. Marty and Newman calculated that if management intensification is extended to the 40 million acres that return at least 5 percent interest on the intensification investment, then sustained-yield capacity can be increased by 2.3 billion cubic feet per year. At 6 percent, sustained-yield capacity can be increased 1.8 billion cubic feet; at 4 percent, 3.3 billion cubic feet.

Focusing on two management intensification activities needed to accelerate the development of today's young stands--reforestation and stand improvement--Marty and Newman showed the following opportunities for management intensification:

	<u>Lowest Return Rate Included</u>		
	<u>7%</u>	<u>5%</u>	<u>3%</u>
Area treated (million acres)	4.1	6.3	12.5
Management investment (million dollars)	210	339	609
Annual yield impact (million cubic feet)	347	533	905

In this analysis, 14.2 million acres were judged to be available for reforestation and stand improvement activities, but depending on the acceptable rate of return on investment, a smaller area would be treated. If a 5-percent rate is

accepted, the area treated would be 6.3 million acres, the investment would be \$339 million, and the sustained annual yield impact after year 2000 would be 533 million cubic feet.

Other intensive management activities could be considered beyond those considered by Marty and Newman and, no doubt, these would provide acceptable rates of return in specific region-type-site classes while adding to the growth impact.

To summarize, the national forests will yield after the year 2000, 3.6 billion cubic feet a year under present levels of management, an additional 2.3 billion cubic feet under intensified management, returning at least 5 percent on the intensification investment (as visualized by Marty and Newman), and further additional amounts with greater intensity of management. Extending the analysis to all Federal commercial forest land, it can be anticipated that the Federal lands will yield after the year 2000 some 4.0 billion cubic feet annually under present levels of management, an additional 2.6 billion cubic feet under intensified management, with additional yields possible under additional intensification of management.

#### Appraisal of Projections

The Federal commercial forest lands have supplied an increasing share of the nation's roundwood products (from 8 percent in 1947 to 23 percent in 1968) during a period in which United States production increased less than 10 percent overall. Here is a strong indication of difficulty in sustaining and expanding timber supply from private lands.

Forest industry, with 67 million acres of commercial forest, produced 2.6 billion cubic feet from its lands in 1962 (45 percent more volume than the national forests). Industry forests are physically more productive, on the average, than the public forests. They are frequently managed intensively, and further intensification of management can be expected in view of industry's expanding consumption targets. Nevertheless, it is not likely that forest industry can do much more than maintain its share of national timber production. Merely to maintain its position as a supplier of 26 percent of the total output of timber products, an 80-percent increase in output will be needed, according to the medium projection of national timber production in 2000. To supply a third of projected national timber production, forest industry would need to produce 7 billion cubic feet annually, a target which may be well beyond the economic growth potential of its lands under present technology.



Non-industrial private ownership, involving millions of landowners and 300 million acres of commercial forest, has accounted for some 50 percent of the total timber output in recent years. Timber growth has increased markedly on these lands largely as a consequence of public programs of protection against fire and pests, public and private educational efforts, tax incentives, and public assistance programs in timber management and marketing. Nevertheless, non-industrial private owners as a group have not consciously adopted timber management plans or invested in timber management. Increases in projected timber output which could be expected from management investment by some non-industrial owners may easily be cancelled by the greater numbers of non-industrial owners whose objectives minimize or preclude timber management. Withdrawal of private forest lands into other land uses, increasing fragmentation among greater numbers of landowners, and increasing forest acquisitions for speculation, second homes, retreats, and recreational pursuits do not suggest the likelihood of much expansion in timber supply from non-industrial private lands.

The present level of output from private non-industrial forests is about 6 billion cubic feet, or 50 percent of the national total. Under medium-level projections of national supply, a 75-percent increase would be necessary for non-industrial forests to maintain their position as suppliers of 50 percent of the nation's timber production. In terms of physical growth potential, such a target would be easily attainable; but in terms of timber-management objectives and timber-management investments being made or that may be forthcoming, there is no basis for expecting an output expansion of such magnitude on a sustainable basis. Historically, as the volume of output has expanded on public and industry lands, it has declined on the private non-industrial lands. Between 1947 and 1968, the absolute decline in timber output from the non-industrial lands has been at least 25 percent.

To suppose that the trend of output from private non-industrial lands can be reversed significantly is highly problematical. Merely to hold output on a sustainable basis at 6 billion cubic feet will require more timber management investment than has been apparent to date. To expand output to an 8-billion-cubic-foot level would require considerable changes in owner objectives and management availability.

If it can be assumed that technology, cultural changes, and public education and assistance can lead to a sustainable output of 8 billion cubic feet on private non-industrial lands, the medium projection of 21 billion cubic feet of timber production in year 2000 will still leave 13 billion cubic feet of output to be maintained from forest

industry and public lands. If, further, forest industry lands can supply 6 billion cubic feet (a conjectural target unless substantial increases in forest land acquisition occur), the residual left for the public lands to supply would be 7 billion cubic feet.

State and local public lands have not been seriously appraised anywhere. The commercial forest in these holdings have a current output of about 0.8 billion cubic feet a year. With some exceptions these lands are not generally managed as intensively for timber production as are the Federal lands or forest industry lands, and management is usually more strongly affected by non-timber objectives. A projected output of 1.5 billion cubic feet, nearly twice the present level, is probably the maximum allocation that can be made reasonably to state and local public lands.

In view of the expectations from other categories of commercial forest landownership, the Federal lands are left with a supply target of at least 5.5 billion cubic feet. This is an attainable objective. If no further reservations of commercial timber occur, the Federal lands will eventually sustain an annual harvest of 4 billion cubic feet under present levels of management. Intensified timber management, extended to all Federal lands where a 5-percent return can be obtained on the intensification investment would raise the sustainable annual harvest to 6.6 billion cubic feet, and a 6-percent rate would yield at least 6 billion cubic feet.

Several major qualifications apply to the projected cut of 5.5 billion cubic feet from Federal lands. One is financial budgets. Timber management budgets must be forthcoming to provide the degree of road construction, regeneration treatment, cultural work, and timber sales administration activity necessary to produce the increased yields projected under intensified management programs.

A second major qualification concerns the policy of reserving commercial forest lands from all timber harvest operations. Such land reservation has a role of increasing importance since public pressures have accelerated the rate of reservation, the ultimate area to be reserved is unknown, and timber yield projections of the Federal lands are predicated on no significant additions to the reservations of otherwise commercial forest land. As of 1967, otherwise commercial forest land had been withdrawn as Primitive and Wilderness Areas on 6.1 million acres of national forests, unknown acreage in national parks, and negligible portions of other Federal agency lands (Table 16). Special cutting restrictions or limitations applied additionally to 2.5



Table 16.--Federal Reservations of Otherwise Commercial Forest Land from Timber Operations, 1967 (Million acres)

	Primitive and Wilderness Areas <sup>a/</sup>	Special Cutting Limitations <sup>b/</sup>
National forests:		
Northeast	Negl.	
North Central	0.3	
South	Negl.	0.4
West	5.8	2.1
Total	6.1	2.5
Bureau of Land Management lands		0.2
National Wildlife Refuge System		0.2
Defense Department		Negl.
Total Federal <sup>c/</sup>	6.1	2.9

<sup>a/</sup> Prescribed by directives and legislative acts.

<sup>b/</sup> Limitations imposed in scenic areas, green belts, recreation sites, parks, and open space.

<sup>c/</sup> National parks omitted because data are unavailable.

Source: Data summarized from (1).

million acres of otherwise commercial forest in national forests, and 0.4 million acres in other Federal agency lands.

A final major qualification concerns the impact of other resource use objectives on timber management. On Defense Department lands and National Wildlife Refuges, other objectives are paramount and timber yields are incidental. But on the national forests and Bureau of Land Management lands, the only significant Federal holdings in respect to timber production, multiple-use management objectives apply. Timber management can be and is modified in recognition of its effects on other resource uses. Conversely, management stressing other use objectives may be modified to recognize the timber-production objective. The net effect of multiple-use accommodations on the Federal lands is difficult to appraise, but if historical trends are recognized and use projections made, it is probable that public forest management will put relatively more stress on watershed, wilderness, and recreational objectives in the future than on timber and forage production. Pressure on Federal agencies to stress non-timber objectives could lead to impairment of the capability of the Federal lands to sustain timber output as well as to expand timber yields in accord with the 5.5-billion-cubic-foot projection that has been made.



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# CHAPTER VI

## WATER

Water is the only commodity discussed in this report which is produced from virtually every acre of Federal land. This commodity is also unique in that its consumption on Federal lands can and does affect the amount of water available for use on non-Federal lands.

The long-term average annual water yield from Federal lands in the 11 Western States averages close to 62 percent of the water yield from all lands. Nearly 96 percent of the population in the West is currently dependent in one way or another upon water from the Federal lands. Future production and use of water on the public lands will, therefore, have a direct bearing upon the well-being of these users. Current and future Western water requirements are compared with average water yields in this chapter. Water supplies are shown to be adequate to meet current and future needs both on and off the public lands. By the year 2000, local water deficits will occur as they do now, but total water yields will be substantially higher than total water withdrawal and consumption requirements.

## Current Water Resources and Uses in the West

The most comprehensive and current inventory of water resources and uses in the United States is that provided by the Water Resources Council in its assessment of The Nation's Water Resources (4). Water yields and current and future uses were assessed in each of 20 water resource regions established by the Council. Five of these regions, the Upper Colorado, Lower Colorado, Great Basin, Columbia-North Pacific and California, are entirely within the Western States. Three more, the Missouri, Arkansas-White-Red and Rio Grande, have significant portions of their area in the West (Figure 1). The state of Alaska is also a water resource region. Water yield and use data for those portions of the Missouri, Arkansas-White-Red, and water resource regions that occur in the 11 Western States have been



estimated in the Public Land Law Review Commission's Study of the Development, Management and Use of Water Resources on Public Lands (2).

#### Average Annual Water Yields

The total average annual water yield (runoff) in the West is estimated at 363.2 million acre-feet. Alaska's runoff is estimated at 650 million acre-feet, with an additional 145 million acre-feet entering from Canada. Water yield in Western States is shown in Figure 1, and by states within water resource regions in Table 1. Differences in water yields between states is significant, as is evident by the heights of the yield scales in Figure 1. The three regions bordering the Pacific Ocean yield two-thirds of the average water runoff in the West. The percentages of total water yields in the Missouri, Arkansas-White-Red, and Rio Grande water resource regions that occur in the 11 Western States are 35, 3, and 70 percent, respectively.

An available indicator of quality of yield is the amount of sediment represented by suspended load and bed-load carried by streams. The average annual total sediment loads of major streams in the 11 Western States, by water resource regions are:<sup>1/</sup>

Water Resource Region	Million Tons
Arkansas-White-Red	6.9
California	37.5
Lower Colorado	29.0
Upper Colorado	254.2
Columbia-North Pacific	61.2
Great Basin	3.7
Missouri	25.9
Rio Grande	17.1

#### Water Use Patterns

The uses of water can be grouped into two classes, natural use and artificial use. Natural use includes such items as evaporation, use by native vegetation, fish and wildlife, and similar items. The uses covered here are the

<sup>1/</sup>A more comprehensive description of sediment loads and an inventory of soluble salts by major rivers are provided in Appendices G and H of the PLLRC study of water resources (4).

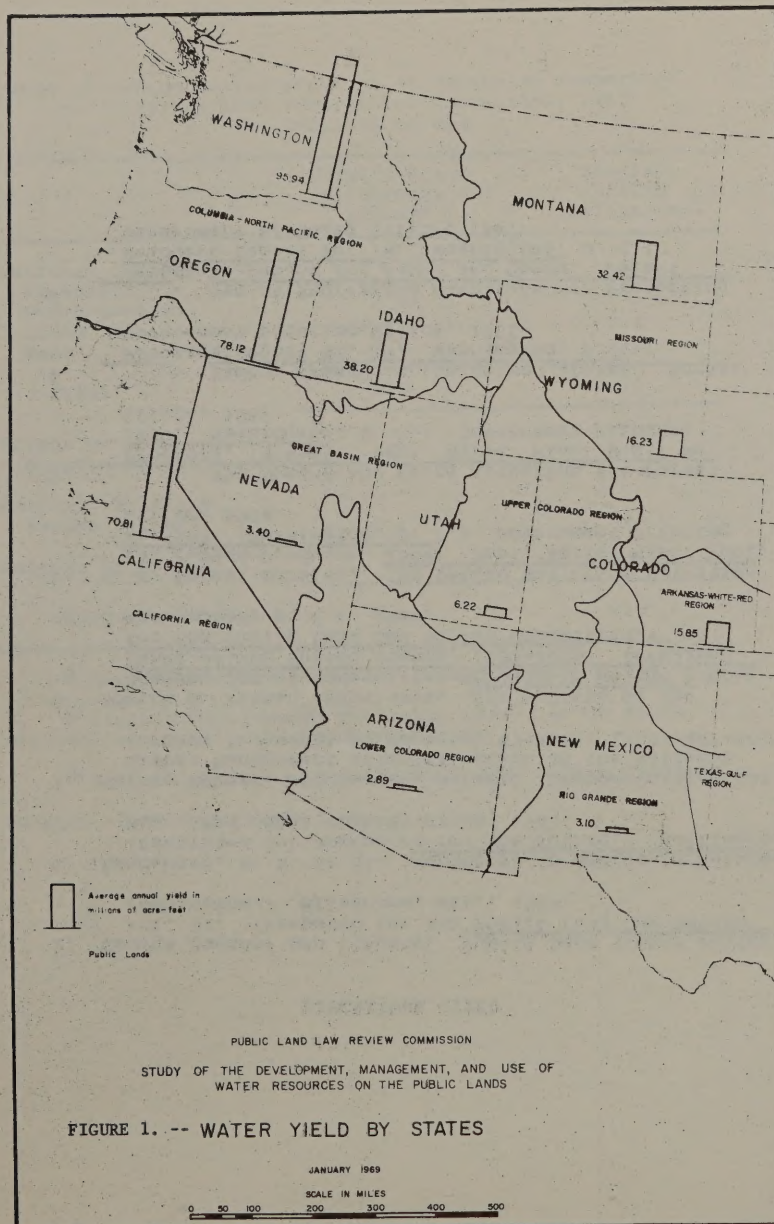




Table 1.--Average Annual Yield by State and Water Resource Region<sup>a/</sup>  
(Millions of acre-feet)

Region	Ark.- White- Red	Texas- Gulf	Rio Grande	Upper Colo.	Lower Colo.	Great Basin	Columbia- North Pacific	Calif.	Total	
State	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Arizona	...	...	...	...	0.07	2.82	...	...	...	2.89
California	...	...	...	...	...	...	...	...	70.81	70.81
Colorado	2.60	1.16	...	1.59	10.50	...	...	...	...	15.85
Idaho	...	...	...	...	...	...	0.46	37.74	...	38.20
Montana	11.83	...	...	...	...	...	...	19.59	...	32.42 <sup>b/</sup>
Nevada	...	...	...	...	...	0.26	2.56	.58	...	3.40
New Mexico	...	0.35	0.04	2.23	0.16	0.32	...	...	...	3.10
Oregon	...	...	...	...	...	...	...	76.06	2.06	78.12
Utah	...	...	...	...	2.76	0.17	3.29	Negl.	...	6.22
Washington	...	...	...	...	...	...	...	95.94	...	95.94
Wyoming	8.70	...	...	...	1.99	...	0.28	5.26	...	16.23
Total	23.13	1.51	0.04	3.82	15.48	3.57	6.59	235.17	72.87	
Total 11 Western States									363.18	
Total Regions									362.18 <sup>c/</sup>	

<sup>a/</sup> Calculations prepared on a cooperative basis between U. S. Geological Survey and the Resource Contractor.

<sup>b/</sup> Natural water yield of Montana is approximately 32.42 million acre-feet with the additional one million acre-feet of water explained in footnote <sup>c/</sup>.

<sup>c/</sup> Total water yield of regions cited above which lie within the 11 Western States does not balance with total water yield of the 11 Western States because runoff of about one million acre-feet per year from 642 square miles in northern Montana flows into the Saskatchewan River and into the Hudson Bay.

Source: (2).

so-called artificial uses for steam power generation, industrial purposes, irrigation, livestock watering, and domestic use. These are summarized in Table 2.

The unit of measure employed in Table 2 is acre-feet of water withdrawn per year. The term withdrawn is not synonymous with consumption. Waters withdrawn from surface streams or by well from ground water are not necessarily consumed. Water withdrawn may be returned to the stream system or groundwater basin for reuse.

Of the total 113.9 million acre-feet of water withdrawn in the 11 Western States in 1965, 83 percent is withdrawn for purposes of irrigation. Power generation uses 6 percent; industrial uses, 4 percent; and domestic uses, 7 percent. Less than half of 1 percent of the withdrawals are for livestock watering. Two-thirds of the withdrawals are in the Coastal States included in the California and Columbia-North Pacific water resource regions. In Alaska, 63 percent of all withdrawals are for industrial use, 24 percent for municipal, and 12 percent for power.

Withdrawals from the 11 Western States within the 8 water resource regions and Alaska are compared with average annual yields in Table 3. Excluding Alaska, total withdrawals in 1965 accounted for about one-third of the average water yield. Water users in the Rio Grande and Lower Colorado water resource regions withdrew 5.3 million acre-feet more water than the average annual yield within these basins. These deficits were made up from waters obtained from the Upper Colorado region under Colorado River Compacts. Withdrawals in Alaska represent a negligible percentage of water yields.

Consumptive uses of water in the Western water resource regions average 50 percent and range from 36 to 62 percent of the water withdrawn. Since the average consumption in the United States is only 29 percent of withdrawals, it is apparent that the Western States are heavy water consumers. Irrigation accounts for 92 percent of the water consumed in the eight Western water resource regions, compared with 50 percent for the rest of the United States.

#### Western Water Requirements, 1980 and 2000<sup>2/</sup>

The Water Resources Council has projected future water requirements and consumption in each of the nation's water

<sup>2/</sup> This section is based on projections made by the Water Resource Council, as presented in The Nation's Water Resources (4). Projections also have been made by Robert Nathan Associates (1) but are not reviewed here because they are considered less reliable.



Table 2.--Water Withdrawn by Water Resource Regions, 1965, Acre Feet per Year  
(Thousand acre-feet)

Region	Power	Industrial	Irrigation	Livestock	Domestic	Total
Missouri <sup>a/</sup>	157	213	13,798	71	422	14,661
Arkansas-White-Red <sup>a/</sup>	24	53	1,133	13	72	1,295
Rio Grande <sup>a/</sup>	20	92	4,632	66	179	4,990
Upper Colorado	22	45	4,346	12	74	4,499
Lower Colorado	11	157	7,168	17	390	7,743
Great Basin	11	250	5,124	18	324	5,729
Columbia-North Pacific	9	2,140	29,574	66	1,444	33,233
California	6,350	1,400	29,344	90	4,572	41,756
Total	6,605	4,351	95,119	353	7,476	113,904

<sup>a/</sup> Estimates use in applicable portions of Montana, Wyoming, Colorado and New Mexico.

Source: U. S. Water Resources Council, The Nation's Water Resources, 7-3-2, as reported in (2).

Table 3.--Comparison of Average Annual Yield with 1965  
Water Withdrawals, by Water Resource Regions  
(Million acre-feet)

Water Resource Region	Average Annual Natural Yield	1965 With- drawals	Difference
Missouri	23.1	14.7	8.4
Arkansas-White-Red	1.5	1.3	0.2
Rio Grande	3.8	5.0	-1.2
Upper Colorado	15.5	4.5	11.0
Lower Colorado	3.6	7.7	-4.1
Great Basin	6.6	5.7	0.9
Columbia-North Pacific	235.2	33.2	202.0
California	72.9	41.8	31.1
Total	362.2	113.9	248.3
Alaska	649.6 <sup>a/</sup>	0.2	649.4

<sup>a/</sup> Does not include water entering from Canada.

Sources: Data for Alaska from (4); for other water resource regions, Tables 1 and 2.



resources regions. Projections for the 8 regions in the West and Alaska are summarized in Table 4. For the Missouri, Arkansas-White-Red, and Rio Grande basins, the data shown are for the entire region, as data pertaining to the 11 Western States portion of these regions is not available.

Projections for the 8 regions in the West show that using 1965 as a base, water withdrawals will increase by 1.3 times by 1980 and by 2.4 times by 2000. Consumptive use will increase by 32 percent by 1980 and by 62 percent by 2000. Requirements by use category, expressed in percent of total requirements will be:

Use	Withdrawals		Consumption	
	1980	2000	1980	2000
Rural domestic	a/	a/	1	1
Municipal	7	8	8	11
Industrial	7	10	3	4
Steam electric power	7	17	a/	1
Irrigation	78	64	96	73
Livestock	1	1	1	1
Total	100	100	100	100

a/ Less than half of one percent

Assuming that the historical average water yield is the quantity of water that will be physically available in the future, by 1980 there will be slightly more than 7 times and by 2000, 4-1/2 times as much water available as is projected to be consumed. Average water yields will exceed water withdrawals by 2.7 times in 1980 and 1.5 times in 2000. Regional deficits will occur, but can be met by importing water from the Upper Colorado region under the provisions of the Upper Colorado River Compact and the Colorado River Compact. Under these Compacts, water is exported to the Missouri, Arkansas-White-Red, Rio Grande, Lower Colorado, California, and Great Basin Regions.<sup>3/</sup>

<sup>3/</sup> Estimates of water requirements shown in Table 4 are probably high, since they are based on a population growth rate of 1.6 percent per year. The Water Resources Council is currently revising estimates of water requirements based on the latest Census projections of 1.3 percent per year.

Table 4.--Comparison of Average Annual Water Yield with Current and Projected 1980 and 2000 Water Use and Consumption, by Region  
(Million acre-feet per year)

Region	Withdrawals			Consumptive Use			Water Yield
	1965	1980	2000	1965	1980	2000	
Missouri <sup>a/</sup>	21.7	26.1	31.2	11.8	14.7	16.8	60.6
Arkansas-White-Red	10.5	19.4	28.4	6.6	9.5	11.9	107.3
Rio Grande <sup>a/</sup>	8.2	9.0	10.7	4.9	5.2	5.6	5.5
Upper Colorado	4.5	6.4	7.4	2.2	3.0	3.5	15.5
Lower Colorado	7.7	9.5	9.4	3.9	4.6	5.2	3.57
Great Basin	5.7	7.9	8.4	2.5	3.7	4.0	6.6
Columbia-North Pacific	33.2	46.4	101.0	11.8	15.2	19.4	235.2
California	41.8	63.0	134.9	23.5	32.7	36.6	72.9
Total	140.2	187.7	331.4	67.2	88.6	103.0	507.1
Alaska	0.2	0.6	1.0	b/	0.1	0.1	649.6

<sup>a/</sup> Includes total region. Data are not available for the Western States portion of the region.

<sup>b/</sup> Negligible.

Source: (4).

The above comparison of water yields and withdrawal and consumptive needs is an oversimplification. Large areas in the West will continue to suffer periodic deficiencies in water supplies due to the uneven time distribution of water yields. In these areas major storage facilities may be needed to store water for use during periods of water shortages. Also, the supply-need comparisons do not consider within stream requirements to provide for fish and wildlife and for maintenance of water quality. Finally, the conclusions reached implicitly assume that the legal and political constraints to the transfer of additional water from one region to another can be overcome.



# Water Resources and Uses on Federal Lands<sup>4/</sup>

## Average Annual Water Yields

Federal lands are the source of a much larger portion of water yield in the 11 Western States than their acreage would indicate. Approximately 46 percent of the West is in Federal ownership. The average annual runoff from these lands is 61 percent of the water yielded from all lands--233 million acre-feet. As shown below, there is no state in the West for which public lands contribute less than half of the total water supply (2):

State	Runoff from Public Lands	
	Million Acre-Feet	Percent All Runoff
Arizona	1.8	61
California	46.2	65
Colorado	15.6	98
Idaho	29.1	79
Montana	21.9	67
Nevada	3.0	88
New Mexico	1.6	52
Oregon	37.9	49
Utah	5.5	89
Washington	48.6	51
Wyoming	12.0	74
Total	223.1	61

Western lands administered by three agencies--the Bureau of Land Management, Forest Service, and National Park Service --yield nearly all (99.4 percent) of the total yield from public lands. Water yields from all Federal agency lands are shown in Table 5. Forest Service and National Park Service lands yield 97 percent of the total yield from public lands and account for 54 percent of the total water yield in the Western States.

The high watershed value of Forest Service and National Park Service lands is attributable to the high water-yielding characteristics of these lands. National Park Service lands being on the average located at higher elevations than lands administered by other agencies, produce the

<sup>4/</sup> Annual water yield and use data for Federal lands in Alaska are not available.

Table 5.--Average Annual Water Yield from Public Lands in the 11 Western States, by State  
(Million acre-feet)

State	BLM	Forest Service	National Park Service	Fish & Wildlife	Other Agencies <sup>a/</sup>	Total Agency Runoff	Total State Runoff	Agency Run-off in % of State Runoff
Ariz.	0.130	1.553	0.021	0.013	0.039	1.756	2.890	61
Calif.	1.810	40.628	3.602	0.026	0.176	46.242	70.810	65
Colo.	0.280	14.956	0.318	0.002	0.036	15.592	15.850	98
Idaho	0.610	28.350	0.028	0.005	0.106	29.099	38.200	76
Mont.	0.310	18.875	2.563	0.026	0.087	21.861	32.420	67
Nev.	1.190	1.630	0.002	0.053	0.116	2.991	3.400	88
N. Mex.	0.180	1.392	0.004	0.001	0.064	1.614	3.100	52
Oregon	0.920	36.306	0.528	0.028	0.131	37.913	78.120	49
Utah	0.330	5.038	0.035	0.003	0.117	5.523	6.220	89
Wash.	0.015	38.386	10.019	0.082	0.048	48.550	95.940	51
Wyo.	0.320	9.336	2.278	0.021	0.045	12.000	16.230	74
Total	6.095	196.450	19.398	0.260	0.938	223.141	363.180	61

<sup>a/</sup> Includes Bureau of Indian Affairs, Bureau of Reclamation, Agricultural Research Service, Department of Defense, and the Atomic Energy Commission.

Source: (2).



greatest yield per acre--1.72 acre-feet per acre per year. Forest Service lands produce 1.45 acre-feet per acre, while Bureau of Land Management lands yield an average of 0.04 acre-feet per acre. The average yield from lands administered by all other agencies is also 0.04 acre-feet per acre.

Sediment production on Federal lands is slightly lighter than on non-Federal lands. The sediment loads of major streams in the 11 Western States averages 435 million tons per year. Of this total, 251 million tons or 58 percent originates on Federal lands. Non-Federal lands contribute 42 percent of the sediment load, but only 39 percent of the water yield.

To produce the water yields shown in Table 5, most Federal agencies actively or coincidentally manage their lands for the production or conservation of water, control of water quality, and flood and erosion control. Between 1958 and 1967, nearly \$66 million was spent on watershed rehabilitation measures: by the Forest Service (\$11 million), National Park Service (\$0.5 million), Bureau of Land Management (\$53 million), and the Fish and Wildlife Service (\$1 million) in the 11 Western States. Forest Service expenditures were primarily for sheet erosion, gully, streambank and lakeshore stabilization and similar erosion control practices. National Park Service, Bureau of Land Management and Fish and Wildlife Service programs involve the construction and maintenance of water control structures, protective fencing, control of undesirable plants, revegetation and other conservation practices. Expenditures by agency and state are shown in Table 6.

Considering the importance of water from public land to the Western economy, the expenditure of only \$66 million in the last 9 years is surprisingly small, but explainable. Most watershed protection and conservation activities undertaken are accomplished as byproducts of other land management activities. For example, both the Bureau of Land Management and Forest Service are obligated to manage their lands for the production of multiple products and services under multiple-use legislation. Multiple-use management, as it relates to water, may involve undertaking projects specifically aimed at water production or conservation. These are the projects funded from the \$66 million mentioned above. But the major thrust consists of measures undertaken to insure that management activities involving timber, recreation, forage and wildlife also enhance or at least do not damage watershed values. The protection of water value in this manner frequently involves elaborate and expensive procedures which are absorbed as a necessary cost of producing

Table 6.--Summary of Expenditures by Federal Agencies for Watershed Rehabilitation on Agency Lands, by State, 1958-1967<sup>a</sup>  
(Millions of dollars)

State	FS	NPS	BLM	BSFW	Total
Arizona	0.4	0.1	2.0	a/	2.6
California	1.6	0.2	1.7	0.2	3.8
Colorado	1.6	b/	5.8	a/	7.4
Idaho	1.8	...	5.8	a/	7.6
Montana	0.7	b/	4.3	a/	5.1
Nevada	0.4	...	10.2	a/	10.8
New Mexico	0.4	...	5.9	...	6.3
Oregon	2.2	...	8.6	0.1	11.0
Utah	0.8	b/	4.4	a/	5.3
Washington	0.4	...	...	0.6	1.0
Wyoming	0.5	b/	4.2	...	4.8
Total	10.9	0.5	53.3	1.1	65.7

a/ Totals may not add due to rounding.

b/ Indicates less than \$50,000.



other products or services. In some cases, opportunities to produce other products may actually be foregone because of potential damage to watersheds. In effect, Federal agencies subsidize water production through expenditures <sup>5/</sup> related to the production of other products and services.

#### Uses of Water Originating on Federal Lands

The water yielded from Federal lands in the West is used both on and off the Federal lands. Of the total water withdrawn for use on Federal lands, only that portion that is actually consumed is not available for later reuse. The discussion below recognizes this relationship by considering uses of water on Federal lands in terms of consumptive uses.

#### Consumptive Use on Federal Lands

Data supplied the PLLRC by Federal agencies show that in 1967 natural and artificial consumptive water uses on Federal lands totaled 2.3 million acre-feet. Assuming that only water yielded from public lands was consumed, this represents only 1 percent of the total water yield from Federal lands.

Consumption of water in the 11 Western States by agency and principal use is shown in Table 7. By far the largest agency user of water is the Fish and Wildlife Service of the Bureau of Sport Fisheries and Wildlife. The Fish and Wildlife Service accounted for 88 percent of all water consumed on Western Federal lands in 1967. Nearly all of the Fish and Wildlife Service consumption was in the form of irrigation for maintenance of wildlife habitat and maintenance of fish and wildlife impoundments in California, Oregon and Utah.

#### Uses on Non-Federal Lands

Estimates have been made in the PLLRC study of water resources of the relative dependency of the Western economy

<sup>5/</sup> The reverse is also true. Expenditures for rehabilitation and development of public lands for water production and conservation often subsidize the production of other commodities. Construction of fences, control of undesirable plants, and revegetation, undertaken by the Bureau of Land Management on Taylor Grazing Act lands with water funds, for example, have obvious benefits for the Agency's grazing program.

Table 7.--Water Requirements (Consumption) on Federal Lands in the 11 Western States, by Agency, Water Resource Region, and Use Category, 1967<sup>a/</sup>  
(Thousand acre-feet per year)

Use and Region	BLM	FS	NPS	BSFW	Other	Total
<u>Water Uses</u>						
Livestock Grazing	12.4	69.8	0.3	0.6	0.7	83.8
Big Game Use	1.2	20.8	0.1	0.1	b/	22.2
Recreation Activities	0.2	49.9	1.0	b/	6.1	57.4
Nurseries and Seed Orchards	...	2.2	...	...	1.5	3.7
Land Occupancy Uses	...	21.0	0.4	b/	51.8	73.2
Other Purposes	...	17.5	0.4	1,988.4	13.2	2,019.3
Total	13.8	181.0	2.3	1,989.1	67.3	2,259.5
<u>Consumption by Region</u>						
Missouri	1.7	19.5	0.3	935.5	8.9	965.9
Arkansas-White-Red	0.7	0.8	b/	b/	4.9	5.8
Rio Grande	0.9	4.9	b/	52.7	16.9	75.4
Upper Colorado	2.5	53.2	0.2	10.9	2.1	68.9
Lower Colorado	1.5	18.6	1.3	62.0	6.1	89.5
Great Basin	3.5	1.9	0.1	475.5	5.4	486.4
Columbia-North Pacific	1.5	18.2	0.3	141.1	12.2	146.7
California	1.4	63.9	0.2	338.3	17.2	421.0
Total	13.8	181.0	2.3	1,989.1	73.2	2,259.5

<sup>a/</sup> Totals may not add due to rounding.

<sup>b/</sup> Less than 51,000 acre-feet per year.

Source: Data supplied by agencies to the Public Land Law Review Commission, as reported in (2) and corrected for errors.



on water yields from Federal land. The uses considered were water required for water storage projects, irrigation of agricultural lands, domestic purposes and hydroelectric power generation.

Western water storage projects having a useful capacity of 5,000 acre-feet or more number 690. Built at a cost of \$12.7 billion, these surface reservoirs have a storage capacity of 207.5 million acre-feet, slightly more than 57 percent of the average annual natural yield of water in the West. The purposes served by these reservoirs include flood control, power generation, quality control, recreation, and the storage of water for use during annual periods of low precipitation for irrigation, municipal water supplies, navigation and similar uses. An estimated 95 percent of the Western population is at least to some degree dependent on these storage projects.

The Bureau of Reclamation and Corps of Engineers are the agencies responsible for the construction and management of Federally owned reservoirs. Of the total capacity of 207.5 million acre-feet, 48 percent is managed by the Bureau of Reclamation, 20 percent by the Corps of Engineers, 23 percent by state and local governments, and 9 percent by private interests. The investments in these reservoirs total \$12.7 billion.

Irrigation of agricultural lands, as has been previously noted, accounts for 83 percent of the water withdrawn and 92 percent of the water consumed in the Western States. According to the 1964 Census of Agriculture (3), only 3 percent of land area of the Western States was irrigated. The distribution by state was:

State	Million Acres
Arizona	1.1
California	7.6
Colorado	2.7
Idaho	2.8
Montana	1.9
Nevada	0.8
New Mexico	0.8
Oregon	1.6
Utah	1.1
Washington	1.2
Wyoming	1.6
Total	23.2

An estimated 95 percent of these irrigated lands are at least to some degree dependent upon water from public lands. The agricultural investment on these dependent lands in 1968 is estimated at \$12 billion. It is not possible to calculate how much of this investment can be attributed to the availability of water from Federal lands because of the "at least to some extent" qualification in the dependency estimate.

The Western population "dependent" upon Federal waters in 1967 is estimated at 30.7 million, 92 percent of the total. Dependence varies from full dependence to partial dependence, and includes dependency upon surface streams partially or entirely originating on public lands and ground-water supplies that are replenished from Federal lands. Population dependency estimates are given by state in Table 8.

Hydroelectric-power-generated capacity in the West totals 23.6 million kilowatts. Although it is again not possible to estimate what portion of this capacity exists because of water yields from Federal lands, it can be said that all streams used for power generation contain some public land waters.

#### Requirements for Water from Federal Lands, 1980 and 2000

Future demands for water produced on Western Federal lands will be determined by consumptive uses on Federal lands, and requirements for irrigation, domestic, municipal, industrial and other uses on non-Federal lands.

Federal agency estimates of future consumptive uses on Federal lands indicate only a moderate increase over current requirements. The following tabulation of these projections shows that consumption in the year 2000 is expected to increase over current use by only 369,000 acre-feet:



Table 8.--Population Dependent upon Water from Public Lands, July, 1967  
(Millions)

State	Total Population	Population Dependent upon Public Land Water		
		Urban	Rural	Total
Arizona	1.6	1.2	0.4	1.6
California	19.2	16.0	2.3	18.4
Colorado	2.0	1.5	0.4	1.9
Idaho	0.7	0.3	0.4	0.7
Montana	0.7	0.3	0.3	0.7
Nevada	0.4	0.3	0.1	0.4
New Mexico	1.0	0.7	0.3	1.0
Oregon	2.0	1.2	0.7	2.0
Utah	1.0	0.8	0.3	1.0
Washington	3.1	2.1	0.7	2.8
Wyoming	0.3	0.2	0.2	0.3
Total	32.0	24.6	6.1	30.7

Source: (2).

(Thousand acre-feet)

State	Annual Consumptive Use on Federal Lands		
	1967	1980	2000
Arizona	85	105	108
California	420	420	452
Colorado	94	131	132
Idaho	195	201	209
Montana	946	1,007	1,024
Nevada	103	113	138
New Mexico	49	51	53
Oregon	119	164	212
Utah	210	217	222
Washington	9	17	27
Wyoming	31	51	53
Total	2,261	2,479	2,630

The 2.6 million acre-feet required in 2000 represents slightly more than 1 percent of the average annual runoff from Federal lands. As is the case now, water requirements of the Fish and Wildlife Service will account for most of this consumption (80 percent).

The amount not consumed on Federal lands will be available to supply the needs of users on non-Federal lands. Total user needs for 1980 and 2000 were compared with average annual water yields by resource region earlier in Table 4 and related text. Since 61 percent of the Western water yield comes from Federal lands, consumption on Federal lands in 1980 and 2000 represents only seven-tenths of 1 percent of total water yields in the West. The conclusions reached in the earlier discussion of total water needs, therefore, are still appropriate. In brief, by 2000 water consumption in the eight water resource regions will represent 20 percent of the average annual yield. Water withdrawals will equal two-thirds of the average yield. The large water surplus will occur in the Upper Colorado and Columbia-North Pacific basins and can conceivably be used to offset deficiencies in other regions if political and legal constraints to transfer of water between regions can be overcome. Local periodic or seasonal water deficiencies in the West will undoubtedly increase pressure on some public lands for additional water yields. To supply these local needs, more active watershed management programs will be required to increase water flows from public lands. Uses that disturb or destroy watershed values or consume large volumes of water, such as some forms of mining



and mineral processing, may have to be curtailed, or, in some instances, forbidden. As of June 30, 1967, 24.0 million acres of Western public domain has been reserved or withdrawn from other uses in favor of water and power projects (22.1 million) and watershed protection and other water uses (1.9 million). The aggregate acreage under intensive management for watershed protection, waterflow-retardation, flood prevention, quality enhancement and other nonpower purposes may have to be substantially increased to supply local water requirements.

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## CHAPTER VII

### ENERGY FUEL MINERALS

The principal energy fuel resources owned by the United States Government are crude petroleum (oil), natural gas (gas), coal, oil shale and geothermal steam. In 1967 leased Federal lands were the source of production of 15 percent of the oil and 13 percent of natural gas produced in the United States. Coal production from leased Federal lands accounted for less than 2 percent of national output. The data presented in this chapter show that Western Federal lands are likely to account for an increasing percentage of gas and oil output by 2000, primarily because of potentials in Alaska and the Pacific outer continental shelf. The extent of this growth is not determinable. Little growth is expected in the relative importance of future coal production from Federal lands.

The following assessment of the probable future demands for energy fuel minerals is based primarily upon data compiled for the Public Land Law Review Commission through contracted studies. The PLLRC sources used include a study of energy fuel resources by Abt Associates (1), the Nossaman, Waters, Scott, Krueger and Riordan study of the outer continental shelf (13), and the Robert Nathan Associates projection of future energy fuel requirements (12). Many additional supplementary data sources were used and are cited in the text.

#### Consumption, Production and Supply Trends in the United States

Between 1947 and 1965, United States consumption of power generated from fossil fuels, hydroelectric and nuclear sources has increased at an average rate of 3.0 percent per year. The fossil fuels--petroleum, natural gas and coal--have been the major input source of energy production. In 1947, the fossil fuels accounted for 99.1 percent and hydroelectric power 0.9 percent of the energy supply. By 1965,

fossil fuel sources accounted for 98.7 percent; hydroelectric power, 1.2 percent; and nuclear sources, 0.1 percent of the total energy production (16).

The stability of the energy source market share held by the fossil fuels masks the substantial changes that have taken place in energy production since 1947. The most obvious change is the growing importance of nuclear power. Power consumption from nuclear sources has been rising at an average annual rate of 47 percent, from 6 trillion BTU's in 1960 to 38 trillion BTU's in 1965. Less spectacular but more pronounced have been the shifts in the relative importance of the three fossil fuels. In 1947, nearly 50 percent of the BTU's produced from fossil fuels was from coal, with petroleum (including natural gas liquids) accounting for 36 percent and natural gas 15 percent. By 1965, the consumption of coal dropped from 580 to 447 million short tons, petroleum consumption increased from 5.2 to 11.2 million barrels per day, and natural gas consumption jumped from 4.3 to 15.7 trillion cubic feet. Associated fossil fuel market shares were: coal, 23 percent; petroleum, 46 percent; and natural gas, 31 percent.

In terms of average growth rates, the use of coal for energy production declined at a rate of 1.5 percent per year between 1947 and 1965. Petroleum consumption increased at a rate of 4.4 percent per year. The use of natural gas has increased at 7.5 percent per year, two and one-half times faster than the 3.0 percent growth rate of total energy consumption.

The shifts that have taken place in fossil fuel consumption are reflected in trends in annual domestic production and the apparent consumption of these commodities, as shown in Table 1. The downward trend in domestic bituminous and anthracite coal production from 684 million short tons in 1947 to 565 million tons in 1967 represents a decline of 17 percent. Bituminous production dropped by 12 percent and anthracite production by 78 percent. Domestic crude petroleum and natural gas production have increased by 1.7 times and 3.9 times, respectively. The apparent consumption (domestic production plus net imports) of petroleum in 1967 is nearly twice as large as consumption in 1947, and the

<sup>1/</sup> Shale oil and tar sands have not yet been used for energy production on a commercial basis. Geothermal steam is used as a commercial source of electrical energy in California, but accounts for a negligible percentage of total United States energy production.



Table 1.--Annual apparent consumption of fossil fuels in the United States from domestic production, net imports, 1947-1967.

Year	Crude petroleum			Natural gas liquids			Natural gas	
	Production	Net imports	Apparent consumption	Production	Net imports	Apparent consumption	Production	Net imports
	(Billion barrels)			(Billion gallons)			(Trillion cubic feet)	
1947	1.9	.1	1.9	5.6	-3	5.3	4.6	*
1948	2.0	.1	2.1	6.2	-2	5.9	5.1	*
1949	1.8	.1	2.0	6.6	-2	6.4	5.4	*
1950	2.0	.1	2.1	7.6	-1	7.5	6.3	*
1951	2.2	.2	2.4	8.6	-2	8.4	7.5	*
1952	2.3	.2	2.5	9.4	-2	9.2	8.0	*
1953	2.4	.2	2.6	10.0	-2	9.9	8.4	*
1954	2.3	.2	2.5	10.2	-2	10.4	8.7	*
1955	2.5	.3	2.8	11.8	-2	11.7	9.4	*
1956	2.6	.3	2.9	12.3	-2	12.1	10.1	*
1957	2.6	.3	2.9	12.4	-2	12.2	10.7	*
1958	2.5	.3	2.8	12.4	-1	12.3	11.0	.1
1959	2.6	.4	2.9	13.5	-1	13.4	12.0	.1
1960	2.6	.4	2.9	14.3	-1	14.2	12.8	.1
1961	2.6	.4	3.0	15.2	-1	15.1	13.3	.2
1962	2.7	.4	3.1	15.7	-1	15.6	13.9	.4
1963	2.8	.4	3.2	16.8	-1	16.7	14.7	.4
1964	2.8	.4	3.2	17.7	*	17.7	15.5	.4
1965	2.8	.5	3.3	18.5	*	18.5	16.0	.4
1966	3.0	.4	3.5	19.7	-1	19.8	18.2	.5
1967	3.2	.4	3.6	21.6	*	21.7	18.2	.5

\* Less than half the unit shown.

a/Preliminary.

Source: 1947 to 1957 data from Neal Potter and R. T. Christy, Jr., Trends in natural resource commodities, Baltimore: Johns Hopkins Press, 1962. 1958 to 1969 data from U. S. Department of Interior Mineral Yearbooks, 1949 to 1967.

Table 1. (Continued)

Year	Bituminous coal and lignite			Anthracite coal		
	Production	Net imports	Apparent consumption	Production	Net imports	Apparent consumption
	(Million short tons)			(Million short tons)		
627	-68.4	559	57.2	-3.5	48.7	48.7
596	-45.6	550	57.1	-6.7	50.4	50.4
434	-27.8	406	42.7	-4.9	37.8	37.8
512	-25.1	437	44.1	-3.9	40.2	40.2
530	-56.4	474	42.7	-5.9	36.8	36.8
463	-47.4	4.6	40.6	-4.6	36.0	36.0
464	-33.5	420	30.9	-2.7	23.2	23.2
387	-30.8	356	29.1	-2.8	26.3	26.3
465	-51.0	414	26.2	-3.2	23.0	23.0
501	-66.2	433	28.9	-5.2	23.7	23.7
493	-75.9	417	25.3	-4.3	21.0	21.0
410	-50.0	360	21.2	-2.3	19.3	19.3
412	-36.8	375	20.6	-1.8	18.8	18.8
416	-36.2	380	18.8	-1.4	17.4	17.4
403	-34.8	368	17.4	-1.4	16.0	16.0
422	-37.9	384	16.9	-1.8	15.1	15.1
459	-46.8	412	18.3	-3.4	14.9	14.9
487	-47.7	439	17.2	-1.6	15.6	15.6
512	-50.0	462	14.9	-.9	14.0	14.0
534	-49.1	485	12.9	-.8	12.1	12.1
553 a/	-49.3 a/	504 a/	12.3	-.6	11.7	11.7



apparent consumption of gas is currently 4.1 times as large as 1947 consumption.

Petroleum and gas production data given in Table 1 include production from the Outer Continental Shelf (OCS). OCS production of oil and gas since 1954 is shown separately in Table 2. All of the production shown was from the Gulf Coast region. Pacific Coast OCS oil and gas leases have been issued since 1963, but production did not get under way until 1968. There are no known commercial petroleum or gas deposits on Atlantic Coast OCS lands.

Outer Continental Shelf petroleum production in 1967 was 219 million barrels, up from 3 million barrels in 1954. Since 1960, OCS oil production has increased at an average rate of 24 percent per year, and has jumped from 1.8 percent to 5.3 percent of total domestic production. Natural gas production from the OCS has also grown rapidly. Gas production in 1967, 1,163 billion cubic feet, is 21 times as high as the 1954 production of 56 billion cubic feet. The growth rate since 1960 has been 23 percent per year. The 1960 production from the OCS accounted for 1.9 percent and 1967 production 6.2 percent of total domestic production.

#### Energy Fuel Requirements, 1980 and 2000

Projections of United States energy requirements and major input sources of power have been made for the Public Land Law Review Commission by Robert Nathan Associates (12). These projections were developed through an updating of projections made by Landsberg and others in a 1963 study for Resources for the Future (11).

Before reviewing Nathan's projections, it should be noted that there are numerous projections of energy requirements available. Because of differing underlying assumptions, none are directly comparable. In a recent Department of Interior (18) study of United States Petroleum through 1980, ten different industry and government projections of 1980 oil, gas, and total energy requirements were compared with Interior's own 1968 projections. This set of 11 different projections is given in Table 3. These projections are presented here for the same reason they were presented in the Department of Interior report--to show that there is current diversity of opinion about the future outlook for energy requirements and individual energy fuels.

Nathan's projections are shown in terms of BTU equivalents in Table 4. Consumption of power is projected to increase from 54 quadrillion BTU's in 1965 to 91 quadrillion

Table 2.--Outer continental shelf crude oil and natural gas production, 1954 - 1967

Year	Crude petroleum (Million barrels)	Natural gas (Billion cubic feet)
1954	3.3	56.3
1955	6.7	81.3
1956	11.0	82.9
1957	16.1	82.6
1958	24.8	127.7
1959	35.7	207.2
1960	49.7	273.0
1961	64.3	318.3
1962	89.7	452.0
1963	104.6	564.4
1964	122.5	621.7
1965	145.0	645.6
1966	188.7	1,007.4
1967 a/	218.6	1,163.0

a/ Preliminary estimates.

Source: (13).



Table 3.--Alternative Projections of United States Energy and Petroleum Requirements for 1980

Source	Date	Total		Oil		Gas	
		Energy Quad.BTU		Mill. % of B/D	Total	Trill. % of Cu.ft. Total	
Natl. Fuel & Energy Study Group <sup>a/</sup>	1962	82.0		3.0	41	21.2	28
Dept. of Interior	1965	85.9		3.1	40	25.6	31
Pan American Petroleum Corp.	1966	87.0		3.2	43	28.0	33
American Gas Association <sup>a/</sup>	1966	...		...	...	27.2	...
Stanford Research Institute <sup>a/</sup>	1967	92.0		3.4	39	27.9	31
Gas Industry Committee	1967	...		...	...	28.6	...
First National City Bank of N.Y. <sup>a/</sup>	1967	87.2		3.2	38	23.6	28
Petrol Industry Foundation	1968	92.0		3.4	39	28.0	31
Texas Eastern Trans. Corp.	1968	97.8		3.6	41	30.8	33
Humble Oil & Refining Co.	1968	97.3		3.6	37	29.8	32
Dept. of Interior	1968	88.1		3.2	41	24.6	29
Robert Nathan Associates <sup>a/</sup>	1968	91.0		5.3	34	27.0	31

<sup>a/</sup> Oil and gas consumption obtained by converting BTU's to barrels and cubic feet at a rate of 5.4 million BTU's per barrel and 1,035 BTU's per cubic foot.

<sup>b/</sup> Medium-level projection.

Source: (12), (18).

Table 4.--Energy consumption in 1965 and the Nathan Associates' medium level projections in 1980 and 2000.

Energy source	(Quadrillion BTUs)		
	1965	1980	2000
Conventional fuels			
Coal	14	20	30
Oil	21	31	53
Gas	17	28	44
Total	52	79	127
Other sources			
Hydroelectric power	2	3	3
Nuclear fuel	Neg.	9	25
Total	2	12	28
Total	54	91	155

Source: (12)



in 1980 and to 155 quadrillion in 2000. This projection appears to be in line with projections made by others. The 1980 projection is higher than five and lower than four of the total energy requirement projections shown in Table 3.

To supply future power requirements, the consumption of fossil fuels is projected to increase from 52 quadrillion BTU's in 1965 to 79 quadrillion in 1980 and 126 quadrillion in 2000. By 2000, energy consumption from coal, oil and gas is expected to increase by 118, 146, and 158 percent, respectively, over 1965 consumption. The percentage of total energy requirements that are projected to be accounted for by fossil fuels and other energy sources, and the percentages of power from these two classes of fuel that are expected to be accounted for by individual power sources, are given below:

Item	1965	1980	2000
(Percent)			
Fuel classes:			
Fossil fuels	96	86	82
Other fuels	4	13	18
Total	100	100	100
Fossil fuels:			
Coal	27	25	24
Oil	40	39	42
Gas	33	36	35
Total	100	100	100
Other fuels:			
Hydroelectric power	100	25	11
Nuclear power	Neg.	75	89
Total	100	100	100

The percentages of market shares of energy input in 1980 and 2000 are:

	1980	2000
Coal	22	19
Oil	34	34
Gas	31	28
Hydroelectric	3	2
Nuclear	10	16
Total	100	100

The projected 1980 market share of 34 percent for oil is substantially lower than the average projection of 40 percent shown by the other 9 oil projections cited in Table 3. Nathan's 1980 projected market share of 31 percent for gas compares closely with the average of 30.7 percent for the other 9 gas projections also given in Table 3.

A translation of Nathan's projected energy requirements into conventional commodity output measures is given in Table 5. The consumption requirements shown include exports, which for coal totaled 50 million tons in 1965 and are projected to reach 70 million tons by 1980 and 100 million tons in 2000. Future exports of oil and gas are expected to be negligible.

The projected consumption of natural gas liquids is included in the projections of oil and gas since they are the products from which these liquids are derived. Consumption of natural gas liquids in 1965 totaled 534 million barrels. The projected consumption included in gas and oil consumption is 976 million barrels in 1980 and 2,133 million in 2000.

The projections made by Nathan assume that adequate economically available supplies of the respective energy sources will be available in the future from either domestic sources or imports. Projected consumptive needs met from domestic sources are expected to be derived from conventional processing of coal, crude petroleum and natural gas up to 1980 but from both new and conventional sources between 1980 and 2000. The new sources mentioned but not quantified include petroleum production from oil shale and tar sands and oil and gas production from coal.

#### Energy Fuel Production on Federal Lands

Minerals on certain public lands are leased to private parties for exploitation under a series of acts. Under the provisions of the Mineral Leasing Act of 1920, public domain



Table 5.--Consumption of energy fuels in 1965 and medium level projection consumption in 1980 and 2000 as reported by Nathan Associates.

Energy source	Unit	1965	1980	2000
Conventional fuels				
Coal	Million tons	524 a/	773	1,031
Oil b/	Million barrels	3,777	5,324	9,126
Gas c/	Billion cubic feet	16,324 d/	27,020	42,163
Other energy sources				
Hydroelectric power	Trillion kilowatt hours	0.20	0.30	0.34
Nuclear fuel	Thousand tons	N.A.	40	75

a/Nathan reported production in 1965 as 512 million tons. The higher figure, 524, apparently arises from consumption of coal inventories.

b/Includes consumption for defense, agriculture, asphalt and road oil, liquid refinery gas, exports, and miscellaneous uses.

c/Includes consumption of natural gas liquids and natural gasoline which originate in natural gas processing, carbon black, pipeline fuel, transmission losses, field use and gas vented.

d/Nathan reports that the consumption figure given compares with Bureau of Mines figure of 16,359 billion cubic feet of gross withdrawals, less quantities used for repressuring.

Source: (12).

lands and certain acquired lands in national forests are leased for mineral production by application to the Bureau of Land Management. National forest lands in the East acquired under the Weeks Act and Appalachian Act are leaseable under the Acquired Land Leasing Act. Outer continental shelf lands are leased on a competitive basis under the Outer Continental Shelf Lands Act of 1961.

Two types of leases are issued: noncompetitive and competitive. Noncompetitive 10-year oil and gas leases are issued only on onshore lands for a payment of a \$10 filing fee by the first applicant. An annual rental of \$0.50 per acre is charged. Competitive leases are issued on all OCS lands and on other lands deemed by the U. S. Geological Survey to contain workable deposits of coal. Oil and gas must be competitively leased when the tract comprehends an area determined by the U. S. Geological Survey to be part of a known geological structure from which oil or gas production has been obtained.

Competitive leases are awarded to a bidder who pays an initial bonus that was offered with his application. Production from onshore leases is subjected to a royalty of from 12-1/2 to 25 percent of the value of production. The minimum OCS royalty is 12 1/2 percent; the current rate is 16 2/3 percent.

Unless otherwise withdrawn, all Federal onshore public domain and acquired lands are available for mineral leasing, subject to the discretion of the Secretary of the Interior. Approximately 882 million acres of Federal land are available for mineral development (3). Only 8.8 million acres have been specifically withdrawn by some form of governmental action from mineral entry and leasing (Table 6). These are mainly lands containing oil shale in Colorado, Utah, and Wyoming.

Withdrawals and reservations for other purposes such as outdoor recreation and wildlife refuges do not automatically foreclose leasing unless there is a specific stipulation to this effect in the withdrawal law or order. When no such stipulation is present, leasing may be permitted if the Bureau of Land Management has been informed by the managing Federal agency that mineral production will not interfere with the purpose of the withdrawal.

Known mineral leasing restrictions on public domain lands withdrawn for specific purposes were officially in force on 104 million acres in 1967. This figure is subject to changes as withdrawal is the prerogative of Federal agencies. Eighty-four percent of the 1967 withdrawals (87



Table 6.--Public Domain Acreage upon which Mineral Entry and Leasing Is Prohibited, as of June 30, 1967, by State

State	Thousand Acres
<hr/>	
Western States:	
Arizona	5.5
Colorado	1,122.0
Utah	4,971.8
Wyoming	1,509.1
Other States:	1,049.4
<hr/>	
Total	8,762.4
<hr/>	

Source: (19).

million acres) are accounted for by withdrawals that restrict all types of use other than the purpose for which the lands were withdrawn. Sixteen percent (17 million acres) has been closed to mineral leasing but not necessarily to other forms of appropriation. Mineral leasing restrictions on withdrawn public domain lands are shown by purpose of the original withdrawal in Table 7.

Mineral leasing withdrawals in Alaska and the Western States are given in Table 8. Of the total withdrawn land, 23 percent is in Wyoming, 18 percent in New Mexico, 18 percent in Montana, 27 percent in California, and 11 percent in Alaska.

The 1947 through 1967 production of fossil fuels on Federal lands is shown in Table 9. For bituminous coal, figures given for coal production on Federal lands as a percentage of total United States output refer to bituminous coal only. Production and percentages of petroleum and natural gas include outer continental shelf production.

The data presented in Table 9 show that the role of leased public lands in petroleum and gas production has increased rapidly over the last two decades. Petroleum production on leased Federal lands as a percent of total production has increased from 4.9 percent in 1947 to 14.6 percent in 1967; gas production increased from 2.5 percent to 13.2 percent. Production from OCS lands has been responsible for the largest part of this increase. OCS petroleum production as a percent of total national production increased from 0.9 percent in 1954 to 8.0 percent in 1967, while onshore production increased from 4.0 percent to 6.6 percent. Gas production from the outer continental shelf has risen from 0.3 percent to 6.6 percent of United States production while onshore production increased from 2.2 percent to 6.6 percent.

Bituminous coal production on leased Federal lands has increased from 8.4 million short tons in 1947 to 9.1 million in 1967. Concurrently, national bituminous production dropped by one-third. As a result, since 1947 production on leased Federal lands as a percent of total production has risen by 23 percent (from 1.3 to 1.6 percent), while actual production has increased by only 10 percent.

Oil and gas production, leases and associated receipts from royalties, bonuses and rentals on public domain lands from 1947 to 1968 are given in Table 10. Similar data for acquired Federal lands are shown in Table 11. OCS production of oil and gas has been given previously in Table 2. The first OCS leases offered by the Department of Interior



Table 7.--Withdrawn Public Domain Lands upon which There Are Restrictions against Mineral Leasing, by Form of Restriction, 1967

(Thousand acres)

Purpose of Withdrawal	Total Acres Withdrawn	Mineral Leasing Restrictions		
		Total	General a/	Specific b/
Administrative Sites	269	48	11	37
Classification	3,646	1,461	1,452	9
Protective Withdrawals	294	231	228	4
Prohibit Mining Entry and Leasing	31,410	7,607	...	7,607
Water and Power Projects	23,311	23,159	23,159	...
Other Water Uses	4,550	67	54	13
Wildlife Refuges	27,988	25,391	25,391	...
Outdoor Recreation	31,670	8,974	1,474	7,500
Townsites and Spatial Uses	2,662	1,519	1,496	23
State Selection	1,624	325	...	325
National Parks and Monuments	17,957	16,018	14,982	1,036
Science, Education and Research	2,394	1,829	1,802	27
Military Purpose	17,172	17,167	17,167	...
Total	164,949	103,795	87,214	16,581

a/ Lands closed to all forms of appropriations, including mineral leasing.

b/ Lands not closed to all forms of appropriations, but specifically withdrawn from mineral leasing.

Source: (19).

Table 8.--Withdrawn public domain lands upon which there are restrictions against mineral leasing, by state and type of restriction. 1967.

(Million acres)

State	Total leasing restrictions a/	General restrictions b/	Specific restrictions c/
Alaska	39.0	38.9	Neg.
Western states	(64.2)	(47.6)	(16.5)
Arizona	9.7	9.3	.4
California	11.4	10.0	1.3
Colorado	3.1	1.7	1.4
Idaho	2.4	1.0	.5
Montana	4.4	3.0	1.5
Nevada	7.6	7.5	.1
New Mexico	4.6	3.6	1.0
Oregon	2.1	1.5	.6
Utah	9.8	4.9	5.0
Washington	2.4	.8	1.6
Wyoming	6.7	3.6	3.1
Eastern states	.7	.7	Neg.
Total	103.8	87.2	16.6

a/ Totals may not add due to rounding.

b/ Lands closed to all forms of appropriation, including mineral leasing.

c/ Lands not closed to all forms of appropriation but specifically withdrawn from mineral leasing.

Source: (1).



Table 9.--Energy Fuel Production on Federal Lands as a Percent of Total United States Production, 1947-1967<sup>a/</sup>

Year	Petroleum		Natural Gas Liquids		Natural Gas		Bituminous Coal	
	Million Barrels	% of U.S.	Million Gallons	% of U.S.	Trillion Cu. Ft.	% of U.S.	Million S. Tons	% of U.S.
1947	90	4.9	178	3.2	0.1	2.5	8.4	1.3
1948	99	4.9	199	3.2	0.1	2.8	9.5	1.6
1949	92	5.0	186	2.8	0.1	2.7	7.7	1.8
1950	103	5.2	184	2.4	0.1	2.2	9.3	1.8
1951	115	5.1	222	2.6	0.2	2.3	8.1	1.5
1952	116	5.1	231	2.5	0.2	3.0	7.5	1.6
1953	131	5.6	240	2.4	0.3	3.5	7.4	1.6
1954	139	6.0	256	2.4	0.4	4.4	5.9	1.5
1955	153	6.1	252	2.1	0.5	4.6	5.8	1.2
1956	168	6.4	267	2.2	0.6	4.9	5.7	1.1
1957	163	7.0	277	2.2	0.7	5.8	5.3	1.1
1958	211	8.6	337	2.7	0.8	6.2	4.9	1.2
1959	253	9.8	397	2.9	0.9	6.9	5.2	1.3
1960	273	10.6	484	3.4	1.0	7.4	5.2	1.3
1961	293	11.2	567	3.7	1.0	7.7	5.8	1.4
1962	318	11.9	640	4.1	1.2	8.5	5.4	1.2
1963	338	12.3	672	4.0	1.4	9.3	7.1	1.5
1964	351	12.6	651	3.7	1.5	9.7	8.2	1.7
1965	374	13.1	597	3.2	1.6	9.7	8.3	1.6
1966	423	14.0	634	3.2	2.0	11.7	9.5	1.8
1967	469	14.6	842	3.9	2.4	13.2	9.1	1.6

<sup>a/</sup> All Federal lands, including Indian and outer continental shelf.

Source: (1).

Table 10.--Gas and Oil Leases, Receipts and Production on Public Domain Lands, 1947-1958

Year	Receipts <sup>a/</sup>	Leases in Effect June 30		Production		
		Number	Acres	Petroleum	Natural Gas	Natural Gas
	(\$ million)	(Thous.)	(Mill.)	(Million barrels)	(Million gallons)	(Billion cu.ft.)
1947	14.5	12.5	8.1	64	126	98
1948	24.1	13.4	10.7	74	152	124
1949	28.4	21.3	19.0	76	158	124
1950	26.7	28.9	23.6	76	145	126
1951	34.3	42.5	32.9	82	141	123
1952	46.8	63.2	48.6	92	179	152
1953	43.8	78.8	59.9	94	184	173
1954	53.6	87.7	66.0	105	197	223
1955	60.0	96.4	73.3	111	211	261
1956	62.8	100.4	73.1	118	203	272
1957	73.3	107.5	78.5	127	211	313
1958	82.5	119.6	93.2	135	218	418
1959	84.3	132.0	107.2	137	280	418
1960	85.9	139.6	113.7	147	304	460
1961	101.5	132.9	101.7	156	344	513
1962	107.2	130.0	93.3	169	401	539
1963	107.4	114.0	75.5	171	436	518
1964	110.0	104.5	67.4	178	414	588
1965	109.3	100.4	64.1	180	457	665
1966	108.0	98.2	61.3	181	438	711
1967	109.0	91.3	53.9	187	493	807
1968	116.0	93.0	56.4	193	711	975

<sup>a/</sup> Includes rentals, bonuses and royalties.

Source: Data for 1947-1964 from (9); for 1966-1968 from (3), (4) and (5).



Table 11.--Gas and Oil Leases, Receipts, and Production on Acquired Federal Lands, 1947-1968

Year	Receipts a/ (\$ Million)	Leases in Effect June 30		Petroleum (Million barrels)	Production	
		Number (Thous.)	Acres (Mill.)		Natural Gas Liquids (Million gallons)	Natural Gas (Billion cu.ft.)
1947	N.A. <sup>b/</sup>	0.2	0.2	N.A.	N.A.	c/
1948	0.4	0.2	0.2	1	2	c/
1949	0.4	0.4	0.5	1	2	c/
1950	0.4	0.5	0.5	1	2	c/
1951	0.7	0.6	0.6	2	1	c/
1952	1.3	1.2	1.1	3	1	5
1953	1.8	2.0	1.9	4	4	3
1954	2.3	2.9	2.8	4	c/	3
1955	2.2	3.2	3.0	3	c/	7
1956	2.6	4.2	3.9	6	c/	14
1957	3.1	4.5	3.9	6	c/	15
1958	3.1	5.4	4.8	5	1	20
1959	2.9	6.4	4.7	5	1	28
1960	3.2	6.8	4.9	5	1	29
1961	3.2	6.4	4.4	5	c/	28
1962	3.4	6.8	4.8	6	1	23
1963	4.2	6.9	5.2	6	1	20
1964	4.2	6.8	4.9	6	1	24
1965	4.5	7.7	5.2	7	c/	41
1966	6.6	7.7	4.9	8	1	23
1967	5.6	7.6	4.2	10	1	28
1968	6.7	8.2	4.7	14	1	25

a/ Includes rentals and bonuses.

b/ Not available.

c/ Indicates less than one-half million gallons or one-half billion cubic feet.

Source: See Table 10.

were in 1954 and applied to the Gulf of Mexico off the coast of Louisiana. From 1954 through 1968, 1,291 leases were awarded covering 5.9 million acres (13). Leases on the Gulf Coast total 1,061 and cover 4.6 million acres. On the Pacific Coast, 230 leases have been issued covering 1.3 million acres. Receipts from OCS leases are shown in Table 12.

As an indicator of the importance of recent oil and gas production on public domain lands in the Western States and Alaska relative to all Federal land, a breakdown of production by land class is summarized for 1960 and 1967 in Table 13. <sup>2/</sup> The percentage distribution of 1967 production between Federal land classes was as follows:

Land Class	Petroleum	Natural	
		Gas Liquids	Natural Gas
Public domain	42	59	34
Acquired	2	Negl.	1
OCS	40	...	42
Other	15	41	23
Total	100	100	100

In 1967, there was no oil or gas produced from leased public lands in Arizona, Idaho, Oregon, or Washington. The remaining seven Western States and Alaska accounted for 92 percent of total public domain petroleum production. For natural gas liquids and gas, the percentages are nearly 100 and 94 percent, respectively.

Coal production and receipts on public lands and coal production on acquired lands from 1947 to 1965 is shown in Table 14. <sup>4/</sup> In 1968, 78 percent of the coal produced from

<sup>2/</sup> 1960 production from acquired lands shown in Table 14 was reported in Public Land Statistics, 1960 (7), and does not agree with production from acquired lands as reported by Clawson (9) and recorded in Table 11. The reason for this discrepancy is not known, but is assumed to be a result of changing definitions of what is included in the definition of military and other lands.

<sup>3/</sup> Total production from Federal lands in 1968 is not available.

<sup>4/</sup> Note that there are unexplainable discrepancies in the data reported in Table 14, as explained in a footnote to the table.



Table 12.--Revenue Received from Bonuses, Rents and Royalties on the Outer Continental Shelf Oil and Gas Leases, 1954-1967

(Thousands of dollars)

Year	Source of Revenue		
	Bonus	Royalty	Rental
1954	140,000	3	3,805
1955	109,000	5	3,356
1956	...	8	3,956
1957	...	11	3,220
1958	...	17	2,376
1959	90,000	26	2,242
1960	283,000	37	3,583
1961	...	47	3,061
1962	489,000	65	8,400
1963	13,000	75	8,423
1964	96,000	86	9,786
1965	...	100	8,503
1966	209,000	132	6,705
1967	510,000	133	7,474

Source: (13).

Table 13.--Federal Land Sources of Gas and Oil Production, 1960 and 1967

Item	1960				1967			
	Petroleum (Million barrels)	Nat. Gas Liquids (Million gallons)	Natural Gas (Trill. cu. ft.)	Petroleum (Million barrels)	Nat. Gas Liquids (Million gallons)	Natural Gas (Trill. cu. ft.)		
Public Domain:								
Alaska	0.2	...	...	11.7	...	...		
Western States:	(145.2)	(302.4)	(449.7)	(171.2)	(491.0)	(751.8)		
California	19.0	68.5	12.8	19.5	54.2	26.2		
Colorado	13.6	14.4	17.6	11.9	22.2	33.5		
Montana	7.5	5.1	5.0	10.9	32.8	3.8		
Nevada	...	...	...	0.3	...	...		
New Mexico	24.5	101.6	294.9	38.0	225.6	517.4		
Utah	5.9	5.4	12.9	10.6	10.6	28.2		
Wyoming	74.7	107.4	106.5	80.0	145.6	142.7		
Eastern States	1.7	2.0	12.4	15.4	2.5	55.2		
All States	147.1	304.4	462.1	198.3	493.5	807.0		
Acquired lands	5.4	0.6	30.7	10.2	0.5	27.6		
Outer continental shelf	35.8	...	207.1	188.7	...	1,007.4		
Military, Indian and other <sup>a</sup>	84.4	179.2	247.1	72.1	347.8	562.0		
Total	272.7	484.2	947.0	469.3	841.8	2,404.0		

<sup>a</sup>/Calculated as the difference between total production on Federal lands as given in Table 9 and the production from the public domain, acquired lands, and the outer continental shelf.

Source: (4) and (7).



Table 14.--Coal Production and Receipts on Public Domain Lands and Production on Acquired and Other Federal Lands, 1947-1965

Year	Public Domain Rents and Royalties (\$ Mill.) (1)	Production (Mill. tons) (2)	Acquired Land Production (Thous. tons) (3)	Other Federal Land Production <sup>c/</sup> (Mill. tons) (4)	Total Federal Production (Mill. tons) (5)
1947	0.8	8.7	N.A.	N.A.	8.4
1948	0.9	8.0	29	1.5	9.5
1949	0.8	8.0	8	b/	7.7
1950	0.8	7.1	67	2.2	9.3
1951	1.1	8.9	73	b/	8.1
1952	1.0	8.1	62	b/	7.5
1953	0.9	7.0	9	b/	7.4
1954	1.0	7.2	86	b/	5.9
1955	0.9	5.6	92	0.1	5.8
1956	0.8	5.7	25	Negl.	5.7
1957	0.8	5.7	21	b/	5.3
1958	0.8	5.2	17	b/	4.9
1959	1.0	4.8	34	0.4	5.2
1960	0.7	5.1	(5.4) <sup>a/</sup> 30	0.1	5.2
1961	0.8	5.1	(5.4) 18	(19) 0.7	5.8
1962	1.0	5.7	(6.0) 15	(14) 0.3	5.4
1963	0.9	4.9	(5.1) 29	(28) 2.1	7.1
1964	1.0	5.4	(5.3) 92	(83) 2.7	8.2
1965	(1.1)	(5.9)	(251)	N.A.	8.3
1966	(1.9)	(5.9)	(169)	N.A.	9.5
1967	(2.1)	(7.1)	(123)	N.A.	9.1

<sup>a/</sup> Numbers in parentheses indicate production data obtained from Public Land Statistics for the year shown. The reason for the differences between 1960-1964 data from (9) and data shown in parentheses is not known.

<sup>b/</sup> Total production reported by Abt Associates (1) as given in Table 9 exceeds production on public domain and acquired lands as reported by Clawson (9).

<sup>c/</sup> Calculated as the difference between column 5 and the sum of columns 2 and 3.

Source: Columns 1-4 from (9) for 1947-1965; from (3), (4), (5) and (6) for 1965-1968. Column 5 from Table 9.

leased public lands was from public domain lands in Colorado (30 percent), Utah (24 percent), and Wyoming (24 percent). Production from all Western public domain lands was 99 percent of production from all United States public domain and acquired land leases (3).

There are 11 million acres of oil shale lands in Colorado, Utah and Wyoming containing as much as 1.8 trillion barrels of shale oil. This resource is more than 60 times the present United States proved reserve of crude petroleum. Federal ownership accounts for approximately 72 percent of the acreage and nearly 80 percent of the known shale oil resource (17). The only leases available for oil shale since 1920 are provisional development leases (13).

There have been no leases of Federal lands for geothermal sources of energy since there is no authorizing legislation.

#### Mineral Fuel Production on Federal Lands, 1980 and 2000

An indicator of the possible future role of leased Federal lands as a source of supply of energy fuels is provided by past production trends. The share of national output of fossil fuels over the last two decades has been shown previously in Table 9. Petroleum production on leased Federal lands increased from 4.9 percent of total production in 1947 to 14.6 percent of production in 1967. The compound rate of growth of this percentage share increase is 5.7 percent per year. The rate of annual growth in the percentage shares for natural gas is 8.7 percent and for both natural gas liquids and coal 1.0 percent per year.

Assuming for the moment that these growth trends will continue to the year 2000, the relative shares of production from Federal lands can be readily determined. At a growth rate of 5.7 percent, leased Federal lands would account for 91 percent of national petroleum production by 2000. A continuation of the 8.7 percent growth rate in percentage shares for natural gas shows that by 1991 the entire output of natural gas in the United States will be from Federal lands. At the historical 1.0 percentage rate, 5 percent of natural gas liquids and coal production will be from Federal lands in 2000.

To anyone with even a nodding acquaintance with the economics of mineral fuel production, the use of compound growth rates to determine future demands for fossil fuels is obviously inappropriate. In fact, any projection



procedure which fails to consider the costs of producing fuels relative to the price received is equally suspect. The reason for this is found in the manner by which fuels on Federal lands are exploited and the existence of both current and expected future physical surpluses of energy fuels in the United States.

Federal control of oil, gas and coal production from the land it owns is indirect. For the outer continental shelf, the government determines when and where potential mineral-bearing land will be leased for minerals. Unless specifically withdrawn, all onshore Federal lands are subject to lease. Government control is limited to the administration of the appropriate leasing laws, insuring that mineral production is not undertaken on withdrawn lands or on lands where such activities would be incompatible with the Federal land-managing agency's management objectives, and that Federal regulations regarding production methods are followed.<sup>5/</sup>

Mineral exploration and exploitation is undertaken by private parties who have obtained these rights through lease. Once a lease has been obtained, the decision to attempt to discover minerals or to undertake production is the lessee's prerogative. He may or may not undertake these activities, depending upon his purpose in acquiring a lease or his alternative prospects on other lands.

Known mineral inventories in the United States and its continental shelf are more than adequate to meet projected future needs. For oil and gas, this can be seen by comparing the Nathan projections of needs in 2000 of 9.1 billion barrels of oil and 42 trillion cubic feet of gas with the United States inventory of petroleum resources shown in Table 15. The inventory of discovered and undiscovered economically recoverable resources in the nation is estimated at 547 billion barrels of oil, 2,737 trillion cubic feet of gas, and 82 billion barrels of natural gas liquids. Marginal and submarginal resource inventories are 2,281 billion barrels of oil, 4,333 trillion cubic feet of gas, and 130 billion barrels of natural gas liquids. These inventories are adequate to meet future needs, but their development will depend upon future costs of production and prices.

Inventories of proved reserves (currently economically recoverable from known deposits) total 31 billion barrels of crude oil and 286 trillion cubic feet of gas. Although

<sup>5/</sup> See literature sources (10) and (14) for a description of the Federal leasing systems.

Table 15.- POTENTIAL UNITED STATES AND WORLD PETROLEUM RESOURCES (CALCULATED FROM DATA TO JANUARY 1, 1966)  
(CONTINENTAL SHELVES INCLUDE STATE LAND OR 0 TO 2500 METERS ISOBATH).

AREA	REMAINING PROVED RESERVES		TOTAL POTENTIAL RESOURCES IN THE GROUND		RECOVERABLE RESOURCES UNDER CURRENT ECONOMICS AND TECHNOLOGY (INCLUDING CUMULATIVE PRODUCTION AND PROVED RESERVES)		MARGINAL AND SUBMARGINAL RESOURCES	
	CRUDE OIL	NATURAL GAS	CRUDE OIL	NATURAL GAS	CRUDE OIL	NATURAL GAS	CRUDE OIL	NATURAL GAS
TOTAL U.S.	31 <sup>(1)</sup>	286 <sup>(1)</sup>	2,828	7,070	547	2,737	2,281	4,333
CONTINENTAL U.S.	27	235	1,470	3,675	367	1,936	1,103	1,937
U.S. CONTINENTAL SHELVES <sup>(5)</sup>	4 <sup>(3)</sup>	31	1,358 <sup>(4)</sup>	3,396 <sup>(4)</sup>	180 <sup>(4)</sup>	800 <sup>(4)</sup>	1,178	2,455
TOTAL WORLD EX. U.S.	357	786	8,400	26,500	716	13,250	6,325	13,250
TOTAL WORLD	368 <sup>(3)</sup>	822 <sup>(7)</sup>	11,228	33,570	922	15,987	9,106	17,593

(1) API-AGA, 1966, V. 20., BREAKDOWN FOR LAND AND SHELVES BASED ON DATA FROM API, AGS, AND UNITED STATES GEOLOGICAL SURVEY.

(2) ACTUAL AMOUNT LARGER THAN SHOWN, SOME NGL FOR SHELF IN WITH CRUDE OIL.

(3) CONTAINS SOME NGL

(4) AMOUNT FROM 0 TO 200 MT. ISOBATH, INCLUDING AMOUNT SHOWN IN TABLE 5 PLUS THAT UNDER STATE JURISDICTION.

(5) HENDRICKS, 1966, P. 17 (FOR RESOURCES ONLY, NOT PROVED RESERVES).

(6) WORLD OIL, AUG. 15, 1967, P. 41

(7) OIL AND GAS JOURNAL, JUNE 11, 1967, P. 97

CRUDE OIL AND NATURAL GAS LIQUIDS (NGL) IN BILLIONS OF BARRELS OF 42 U.S. GALLONS.  
NATURAL GAS IN TRILLIONS OF CUBIC FEET.

Source: (13).



new resources are constantly being discovered and proved reserves will increase, proved reserves may not be sufficient to meet future projected needs under current prices and cost relationships and still maintain desirable reserve to production levels.<sup>6/</sup> If this occurs, prices will be forced to rise, allowing inventories now classified as resources to become reserves, and possibly the economical production of oil from shale oil<sup>7/</sup> and the production of oil and gas from coal should the technology be available.

For coal, Nathan projects that 1,031 million tons will be consumed in 2000. According to the Bureau of Mines, remaining recoverable reserves of coal are estimated at between 788,000 and 1 trillion short tons. Reserves recoverable at current prices and technology are estimated at 380,000 million short tons.

The implications of the leasing system and known inventory levels for the future role of Federal lands is clear, but less than specific. The importance of leased Federal lands as a source of energy fuel will be dependent upon the extent of future discoveries and proof of reserves that will occur on Federal lands and the costs of production from these reserves relative to the costs of production from other areas. Neither of these items is projectable.

Production of fossil fuels from Western public domain lands and the OCS will be subject to the same economic forces as production from all other Federal lands. According to the PLLRC study of energy fuels (1), current reserves of coal, oil and gas on private lands in the West are more than adequate to meet future needs at least through 1985, even if no new fields or pools are found. Again, the obvious conclusion is that the only increases from public lands that can be expected will occur when the cost of production and marketing from leased Federal lands is less than the costs of production and marketing on private lands.

For oil and gas, the large investments that have been recently made by industry in the exploration and leasing of the Pacific Coast OCS and lands in the Alaskan north slope indicate that the producing industry feels that these two sources will prove to be an economical source of petroleum and gas to serve future consumptive needs. If economical production can be obtained from public lands in Alaska and

<sup>6/</sup> The Department of Interior has estimated that with continued drilling and improvements in recovery technology, proved petroleum reserves will ultimately yield nearly twice the estimated reserves or 62 billion barrels (17).

<sup>7/</sup> Unpublished 1964 Department of Interior projections of shale oil production from public lands are 100 million barrels by 1980 and 350 million barrels by the year 2000.

the Pacific Coast, it is likely that the public lands will supply an increasing percentage of the oil and gas produced in the West. However, this increase may be offset by a decline in production from other public lands as previously held markets are lost to new sources of production.

Recent announcements of planned installations of nuclear power-generating facilities in the Pacific Coast states will probably result in a reduction of the relative importance of coal from leased Western Federal lands, but the absolute level of leased public land production is expected to increase moderately. However, the trend toward the location of coal power plants at the site of coal mining operations could result in significant increases in production of coal in certain locations.

Federal policy pertaining to the leasing of lands can influence the production from Federal lands, but as indicated earlier, this influence is indirect. Mineral leases on the OCS are issued only when the Department of Interior offers such leases. Should the government wish to increase the production of fuels from its lands, more OCS leases could be offered. Production could similarly be discouraged by not offering lands for lease. Similarly, efforts could be made to expedite the leasing of oil shale lands now withdrawn.

#### non-competitive

The efficiency of current/leasing procedures on on-shore lands other than oil shale lands leaves much to be desired. A substantial revision of these procedures would probably result in more production from Federal lands. Also, the current low rental fees charged on nonproducing leases almost appear to be designed to assure that leases are awarded to speculators rather than to private parties that have the ability and potential to bring leased lands into production. (1). In general, the current Department of Interior leasing system for onshore lands seems to be at odds with the Department's announced objective for its energy fuel program of assuring a dependable supply of energy at appropriate social and economic costs (18).

Withdrawals of Federal land from mineral leasing has some impact on the potential level of production of Federal lands. As of 1967, only 17 million acres of public domain land have been reserved specifically from mineral leasing. An additional 87 million acres has been withdrawn for purposes which in the opinion of the managing Federal agency are incompatible with all forms of mineral production. If continued withdrawals occur, there will be simply



less land available for lease. Industrial interests frequently dispute withdrawals and claim that the production of at least oil and gas on withdrawn lands more often than not is compatible with the purpose for which the land was withdrawn. However, even if the industry assertions of compatible use were true, a reversion of withdrawn land to leasable status would probably have only a negligible impact on fossil fuel production from Federal lands. Over the last two decades an average of less than 3 percent of the Federal acreage under gas and oil leases has produced gas or oil.

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## CHAPTER VIII

### SELECTED NONFUEL MINERALS

Two classes of nonfuel minerals are considered in this chapter--minerals consumed primarily in world fertilizer markets and other selected minerals and metals. Minerals used in fertilizers include phosphates, potassium and sulfur. The metals and other minerals reviewed are sodium iron and steel, aluminum, copper, lead, magnesium, mercury, nickel, molybdenum, tungsten, vanadium, diatomite, and sand and gravel. Each of these commodities is of specific interest to the Public Land Law Review Commission (5).

Historical production and consumption and projections of future consumption are reviewed for each mineral. The relative shares of production accounted for by output from Federal lands is reviewed only for a selected group of minerals. These are the minerals that are leased under the Mineral Leasing Act (phosphates, potassium, sodium and sulfur), Outer Continental Shelf Act (sulfur), and the Acquired Lands Leasing Act (copper and lead in the Eastern United States), or sold under the "Common Varieties" Act (stone, gravel and similar materials).

The remaining nine minerals and copper and lead in the West are "locatables" and are not produced on public lands per se. Most of the metalliferous minerals discovered on public land are acquired by private parties by location under the provisions of the Mining Laws of 1872. Production from mining claims and patented public lands is not considered as Federal production, but rather as production from private lands. In addition to the metals, sulfur is also produced from both patented and nonpatented mining claims.

#### Historical Trends in Production and Consumption

##### Phosphate Rock, Potash, and Sulfur

Annual data reflecting the production, export and apparent domestic consumption of phosphate rock, potash and



sulfur from 1948 through 1965 are given in Tables 1, 2, and 3. Production data were obtained from the Bureau of Mines Mineral Yearbooks (2). Consumption and export data were derived from numerous sources by Nathan Associates (5).

Phosphate rock production in gross tonnage and exports and domestic consumption in terms of the quantities of phosphorous pentoxide ( $P_2O_5$ ) contained in calcium phosphates and other materials are given in Table 1. In 1965, the last year for which consumption data are shown in Table 1, apparent domestic consumption accounted for 72 percent of total consumption with exports accounting for 18 percent.

Apparent domestic potash consumption in 1965 totaled 3.4 million short tons of potassium oxide ( $K_2O$ ) equivalent (Table 2). An additional 0.6 million short tons was exported. Approximately 95 percent of the domestic consumption of this mineral is used as a fertilizer in domestic agriculture or is exported in the form of fertilizer materials. Domestic consumption of potash for use as a fertilizer increased at a compound rate of 7.2 percent from 1948-1950 to 1963-65. Exports were relatively unimportant until 1955, accounting for 6 percent of consumption in 1948 and 16 percent in 1968. Domestic potash ( $K_2O$ ) equivalent production increased from 1.9 million tons in 1948 to 3.1 million tons in 1965.

Consumption of all forms of sulfur more than doubled between 1948 and 1965, increasing at an average annual compound rate of 3.3 percent (Table 3). The major use has been for the production of sulfuric acid. Sulfur consumption from native sulfur accounted for 84 percent of total consumption in 1948 and 52 percent in 1968. This indicates a trend toward an increasing industry reliance upon sulfur supplies recovered from refinery gases and other sources. Total United States sulfur production increased from 5.4 million long tons in 1948 to 8.2 million long tons in 1965.

#### Metals and Other Minerals

United States consumption of iron and steel, iron ore, aluminum, copper, lead and the minor metals and minerals from 1948 through 1965 is shown in Table 4. Data are expressed as demand figures, including consumption of domestic production for domestic uses and export, plus the consumption of imports. Export trends are shown separately for iron ore, aluminum, magnesium, molybdenum and diatomite in Table 5.

Table 1.--United States Phosphate Rock Production, Apparent Consumption, and  $P_2O_5$  Equivalent Consumption for Export and Domestic Uses, 1948-1965  
(Million long tons of gross weight and  $P_2O_5$  equivalents)

Year <sup>a/</sup>	Gross Weight		Tonnage in $P_2O_5$ Equivalents			
	Production	Apparent Consumption	Export	Domestic Consumption		Total <sup>b/</sup>
				Agriculture	Industrial	
	(1)	(2)	(3)	(4)	(5)	(6)
1948	8.7	7.6	0.3	2.1	0.3	2.7
1949	9.0	7.8	0.4	2.1	0.3	2.9
1950	10.2	8.5	0.6	2.2	0.4	3.1
1951	11.1	9.5	0.5	2.4	0.6	3.6
1952	11.3	10.0	0.4	2.5	0.6	3.5
1953	12.5	10.5	0.6	2.6	0.8	4.1
1954	13.0	10.8	0.8	2.5	0.8	4.0
1955	13.2	11.4	0.7	2.4	0.8	4.0
1956	14.1	11.3	0.9	2.5	0.9	4.2
1957	14.6	11.6	1.0	2.5	0.9	4.4
1958	14.8	12.1	0.9	2.5	0.9	4.4
1959	16.1	13.2	1.0	2.8	0.9	4.7
1960	17.2	13.2	1.3	2.7	1.0	5.0
1961	17.8	14.1	1.3	2.8	1.0	5.2
1962	19.1	15.3	1.3	3.0	1.2	5.4
1963	19.9	15.5	1.5	3.3	1.2	5.9
1964	22.1	16.6	1.8	3.5	1.4	6.8
1965	26.0	19.5	2.1	3.6	1.5	7.2

<sup>a/</sup> Calendar years except for column (4), which is for year ending June 30.

<sup>b/</sup> Totals may not add due to rounding.

Sources: Columns (1) and (2) are from (2); other columns are from (5).



Table 2.--Potash Production and Consumption in the United States, 1948-1965  
(Million short tons, approximate K<sub>2</sub>O equivalent)

Year/ Producers	Sales by Marketable Quantity (1)	Production (2)	Apparent Domestic Consumption <sup>a</sup> (3)	Domestic Consumption by User		
				Fertilizer Manufacturers (4)	Chemical Industry (5)	Possible Error 6=(4)+(5)-(3) (6)
1948	1.1	N.A.	1.1	1.0	C/	0.1
1949	1.1	N.A.	1.1	1.1	0.1	0.1
1950	1.3	N.A.	1.4	1.2	0.1	0.1
1951	1.4		1.7	1.4	0.1	0.1
1952	1.6		1.7	1.7	0.1	C/
1953	1.7		1.8	1.8	0.1	C/
1954	1.9	1.8	2.0	1.9	0.1	C/
1955	2.0		2.1	2.0	0.1	C/
1956	2.1	2.2	2.1	2.1	0.1	0.1
1957	2.1	2.3	2.1	2.1	0.1	0.2
1958	2.3	2.1	2.3	2.1	0.1	C/
1959	2.5	2.4	2.4	2.4	0.1	0.2
1960	2.6	2.6	2.3	2.4	0.1	0.2
1961	2.5	2.7	2.3	2.5	0.1	0.4
1962	2.7	2.5	2.6	2.6	0.2	0.2
1963	2.7	2.9	2.9	2.9	0.2	0.2
1964	3.0	2.9	3.2	3.1	0.2	0.1
1965	2.9	3.1	3.4	3.3	0.2	0.1

<sup>a</sup>/Calendar years, except for column (4) which is for years ending June 30.

<sup>b</sup>/Potassium salts sales or use, plus imports minus exports.

<sup>c</sup>/Less than 500,000 short tons.

Sources: Columns (1) and (2) from (1); other columns from (5).

Table 3.--Sulfur Production, Exports and Apparent Consumption  
in the United States, 1948-1965  
(Million short tons)

Year	Domestic Production (1)	Apparent Domestic Consumption	
		All Forms <sup>a</sup> (2)	Native Sulfur <sup>b</sup> (3)
1948	5.5	4.4	3.7
1949	5.4	4.1	3.4
1950	5.0	5.0	4.2
1951	6.2	4.8	3.8
1952	6.3	4.8	3.7
1953	6.2	5.0	3.9
1954	6.7	4.9	3.7
1955	7.0	5.6	4.2
1956	7.8	5.7	4.3
1957	7.0	5.6	4.0
1958	6.1	5.3	3.7
1959	6.2	5.9	4.2
1960	6.7	5.9	4.0
1961	7.2	5.9	3.9
1962	6.8	6.2	4.1
1963	6.6	6.6	4.3
1964	7.1	7.3	4.7
1965	8.2	8.0	5.1

<sup>a</sup>/Includes imports and native sulfur.

<sup>b</sup>/Sales of native sulfur adjusted for changes in inventory, plus imports of native sulfur minus exports.

Sources: Column (1) from (2); other columns from (5).



Table 4.-- U.S. Demand for Selected Metal and Mineral Commodities, 1948-65

Year	Iron and Steel <sup>a</sup>	Iron ore, <sup>b</sup> gross wt.	Iron ore, <sup>c</sup> Fe con- tent	Aluminum, <sup>d</sup> lb.	Copper <sup>e</sup> lb.	Copper <sup>f</sup> wire mills	Copper <sup>g</sup> brass mills & other	Lead <sup>h</sup> lb.	Zinc <sup>i</sup> lb.	Magnesium <sup>j</sup> lb.
	--- million long tons									
1948...	67.9	103.5	51.7	730.8	2,282.7	765.8	1,516.9	1,133.9	1,202.3	17.5
1949...	60.2	87.1	46.9	932.1	1,717.2	623.7	1,093.5	957.7	974.5	18.6
1950...	74.9	100.3	53.3	1,397.9	2,317.7	713.4	1,604.3	1,238.0	1,350.5	28.5
1951...	83.3	116.2	58.9	1,429.7	2,294.1	710.2	1,593.9	1,184.8	1,326.1	46.1
1952...	71.0	105.5	50.5	1,527.9	2,413.3	739.5	1,573.8	1,130.8	1,211.6	55.1
1953...	83.4	126.9	61.7	1,930.4	2,338.1	753.0	1,585.1	1,201.6	1,342.4	51.8
1954...	65.0	96.4	47.5	1,967.0	1,956.4	668.6	1,287.8	1,094.9	1,180.7	50.8
1955...	87.2	120.4	63.6	2,111.2	2,349.3	812.7	1,536.6	1,212.6	1,459.3	64.9
1956...	86.8	124.9	61.5	2,127.6	2,290.2	864.6	1,425.6	1,209.7	1,320.3	68.0
1957...	84.2	129.9	64.2	2,135.6	2,056.8	773.6	1,283.2	1,130.1	1,231.6	56.7
1958...	63.1	93.4	47.8	2,092.2	1,893.5	740.3	1,143.2	986.4	1,142.2	45.1
1959...	75.6	97.4	50.3	2,408.3	2,275.0	836.2	1,380.8	1,091.1	1,278.4	54.0
1960...	76.1	107.6	54.9	2,015.6	2,018.0	828.8	1,189.2	1,021.2	1,158.9	52.5
1961...	71.1	102.7	53.2	2,320.4	2,110.1	823.8	1,286.3	1,027.2	1,207.5	60.3
1962...	76.4	102.5	53.0	2,705.2	2,297.6	922.9	1,374.7	1,109.6	1,333.3	63.9
1963...	83.1	110.8	58.6	3,040.1	2,486.2	1,036.2	1,450.0	1,163.4	1,414.2	76.6
1964...	94.1	129.2	69.7	3,216.5	2,642.9	1,097.5	1,545.4	1,202.1	1,535.8	83.3
1965...	105.6	132.2	71.3	3,736.2	2,883.7	1,223.4	1,660.3	1,241.5	1,742.1	101.0

Continued --

Table 4.-- U.S. Demand for Selected Metal and Mineral Commodities, 1948-65, Continued--

Year	Mercury <sup>k</sup> Thou. flasks	Manganese <sup>l</sup> Thousand short tons	Nickel <sup>m</sup> lb.	Molybde- num <sup>n</sup> lb.	Molybde- num <sup>o</sup> lb.	Tungsten <sup>p</sup> in steel	Tungsten <sup>q</sup> lb.	Vanadium <sup>r</sup> Short tons	Diatomite <sup>s</sup> Thousand short tons	Sand, gravel, <sup>t</sup> & crushed stone Million short tons
1948...	46.3	1,538.4	93.6	20.2	25.3	5.7	3.2	710	240.9	543.2
1949...	39.9	1,265.2	68.3	20.0	32.3	3.2	1.8	540	240.9	543.2
1950...	49.2	1,520.5	100.0	26.0	37.4	3.4	3.8	1,613	302.8	620.1
1951...	56.8	1,710.8	86.7	33.7	38.9	2.8	8.0	1,525	302.8	620.1
1952...	42.6	1,714.0	101.4	32.7	38.2	2.8	4.9	1,613	302.8	745.3
1953...	52.3	2,097.9	105.7	31.2	38.2	1.3	2.8	1,702	368.4	966.2
1954...	42.8	1,637.8	94.7	34.8	43.4	2.9	6.0	1,880	368.4	1,060.2
1955...	57.2	2,017.6	110.1	45.7	60.6	3.9	5.9	2,200	368.4	1,128.5
1956...	54.1	2,254.8	122.5	39.0	64.4	2.8	5.3	2,000	449.8	1,161.8
1957...	52.6	1,741.6	110.1	45.7	60.6	3.9	5.9	2,200	449.8	1,217.9
1958...	54.9	1,515.9	79.0	31.3	43.3	1.7	3.8	1,400	449.8	1,234.3
1959...	51.2	1,946.4	108.2	44.8	75.0	2.3	6.8	2,101	482.2	1,334.3
1960...	55.8	1,717.8	118.5	42.3	77.9	2.3	6.8	2,240	482.2	1,430.9
1961...	65.3	1,865.3	118.7	41.0	56.5	2.7	7.7	2,570	482.2	1,508.7
1962...	78.0	1,841.7	124.5	49.2	75.7	2.7	8.4	2,806	580.3	1,591.8
1963...	82.6	2,241.8	146.9	56.4	91.2	3.2	10.4	4,708	580.3	1,685.7
1964...	76.5	2,866.1	172.1	48.6	72.7	3.2	10.4	4,708	580.3	1,685.7

<sup>a</sup> Domestic shipments plus exports plus imports [1].<sup>b</sup> Domestic consumption including imports plus exports.<sup>c</sup> Domestic consumption including imports.<sup>d</sup> Bureau of Mines [7].<sup>e</sup> Copper Development Association [2].<sup>f</sup> Bureau of Mines [7] and Bureau of Census [6, 7].<sup>g</sup> Bureau of Mines [7] and Bureau of Census [6, 7].<sup>h</sup> Excluding tungsten used in steel making [7].<sup>i</sup> Figures are three-year average sales reports, includes exports [7].

Source: [5].



Table 5.--Export Demand for Selected U.S. Metals and Minerals, 1948-65

Year	Iron Ore <sup>a/</sup>	Aluminum	Magnesium	Molybdenum	Diatomite
	Mil. long tons	Thousand short tons		Mil. lbs.	Thou. short tons
1948...	2.7	49.5	.4		n.a.
1949...	2.4	37.2	.7	5.3	n.a.
1950...	2.5	21.3	.9	6.2	n.a.
1951...	4.3	13.4	.8	3.7	n.a.
1952...	5.1	10.3	1.2	6.2	n.a.
1953...	4.4	14.7	3.0	7.0	n.a.
1954...	3.1	49.4	3.3	13.5	n.a.
1955...	4.5	32.3	8.5	14.6	n.a.
1956...	5.5	66.4	3.9	18.0	n.a.
1957...	5.0	59.9	1.6	25.5	n.a.
1958...	3.6	80.8	1.1	12.0	60
1959...	3.0	162.5	2.4	18.9	71
1960...	5.3	382.6	5.1	30.2	92
1961...	5.0	236.1	6.7	35.7	95
1962...	5.9	258.7	7.0	15.6	109
1963...	6.8	291.7	16.2	26.5	112
1964...	7.0	349.4	16.8	24.9	128
1965...	7.1	313.8	17.8	24.1	114

a/ Gross weight.

Source: (5).

# Projected Demands, 1980 and 2000

## Phosphate Rock, Potash and Sulfur

Projections of 1980 and 2000 consumption of phosphate rock, potash and sulfur for domestic use and export are summarized in Table 6. These projections are the medium-level projections made by Nathan Associates (5).

For phosphate rock, the medium projection assumes that current fertilizer technology will improve only modestly in the future. Under this assumption, consumption is expected to increase from the 1965 level of 7.2 million long tons to 13.2 million in 1980 and 26.9 million in 2000. Substantial quantities of the projected consumption are allocated for export use. For the 1980 projection, 47 percent, and for the 2000 projection, 61 percent of total consumption is allocated for export. Exports accounted for only 29 percent of consumption in 1965.

Potash consumption is expected to more than double by 2000, rising from 4.2 million short tons of potash in K<sub>2</sub>O equivalents in 1965 to 8.8 million tons by 2000. Exports accounted for 16 percent of total United States consumption in 1965. Based upon past trends and expected needs for fertilizers in developing countries, this percentage is projected to increase to 20 percent by 1980 and to 26 percent by 2000.

In 1965, 10.6 million long tons of sulfur were consumed in the United States, 25 percent of which (2.7 million long tons) was exported. Under the medium projections, 1980 consumption will be 19.1 million tons with 22 percent exported. Consumption in 2000 is projected at 38.4 million long tons with 17 percent being exported, largely to foreign manufacturers of phosphatic fertilizers.

## Metals and Other Minerals

Projections of future consumptive requirements for metals and other minerals developed by Nathan Associates were made under the assumption that changes in the relative

<sup>1/</sup>A referee of this report has noted that the export components of the Nathan projections may be overly optimistic. Developing nations are the principal export market. There is a recognized need for fertilizers in these nations, but also a lack of capital needed to purchase the needed quantities. Additional factors which may curtail U.S. exports are new discoveries abroad, nationalism and worldwide excess production capacity.



Table 6.--Export and Total Consumption of Phosphate Rock, Potash, and Sulfur, 1965, and Medium-Level Projections for 1980 and 2000

Commodity	Unit	1965		1980		2000	
		Export	Total	Export	Total	Export	Total
Phosphate rock	Million long tons $P_2O_5$	2.1	7.2	6.2	13.2	16.5	26.9
Potash	Million short tons ( $K_2O$ )	0.6	4.1	1.3	6.4	2.3	8.8
Sulfur	Million long tons	2.7	10.6	4.2	19.2	6.4	38.4

Source: (5).

consumption of different metals brought about by price-induced substitution will not be significant. The projections were based on consumption trends over the 1948-1965 period. Nathan's projection of total domestic and export consumption in 1980 and 2000 as compared with 1965 consumption is reproduced in Table 7. Projected export demands are shown separately in Table 8.

The projections given in Tables 7 and 8 differ considerably from projections made by Landsberg and others in 1963 (4). However, because different assumptions underlie the Nathan and Landsberg projections, they are not comparable. As a qualification of Nathan's projections, it should be noted that they are not accepted or endorsed by the U. S. Bureau of Mines. The Bureau has recently developed their own projections of demands for minerals which apparently differ significantly from those prepared by Nathan. The extent of the differences cannot be documented as the Bureau of Mines' projections are presently unpublished.

#### Nonfuel Mineral Output from Federal Lands

The Bureau of Land Management administers the leasing and sale of mineral resources on lands owned by the United States. Authorizing legislation controlling leases and sales include the Mining Law of 1872, as amended, the Mineral Leasing Act of 1920, the Outer Continental Shelf Act of 1953, the Mineral Disposal Act of 1947, and the "Common Varieties" Act of 1955 (PL 167).

The Mining Act of 1872 and its amendments apply to all onshore public domain not specifically exempted by law or administrative action. In addition, there are 61.7 million acres for which surface rights have been transferred to private owners with mineral rights reserved to the United States, which are subject to the provisions of the mining laws (8).

Under the provisions of the mining laws, private interests may enter nonwithdrawn public lands or some patented lands for which mineral rights have been reserved for the purposes of mineral exploration. Claims may be filed for the exclusive right to search for minerals on small tracts of land for as long as diligent exploration is carried out. If minerals are found, the claim may be held indefinitely as long as a minimum of \$100 per year is spent for assessment.

Valid mining claims presented for patent must be patented by the Federal government if minerals have been



Table 7.-- Projected U.S. Consumption plus Export for Selected Metals and Minerals, 1965 and Projected 1980 and 2000

Commodity	Unit	1965	1980			2000		
			Low	Medium	High	Low	Medium	High
Iron and steel.....	mil. long tons	105.6	246.0	255.8	261.9	417.2	451.1	535.4
Iron ore <sup>a/</sup> .....	do.	72.8	194.1	201.7	206.7	329.3	356.1	422.6
Domestic consumption <sup>b/</sup> plus exports.....	do.	132.2	313.5	325.2	333.0	511.6	551.4	650.8
Aluminum.....	thou. short tons	3,736.2	8,202.7	9,054.7	10,586.4	15,930.2	19,138.5	21,295.1
Copper.....	do.	2,883.7	4,208.2	4,492.6	4,585.1	6,703.6	7,715.1	8,402.1
Wire mills.....	do.	1,223.4	1,974.5	2,145.9	2,202.0	3,458.0	4,056.4	4,465.0
Brass mills and other.....	do.	1,660.3	2,233.7	2,356.7	2,383.1	3,245.6	3,658.7	3,937.1
Lead.....	do.	1,241.5	1,337.4	1,365.8	1,375.7	1,596.4	1,701.5	1,773.3
Zinc.....	do.	1,742.1	2,683.3	2,957.2	3,054.4	6,732.9	9,783.2	12,626.7
Magnesium <sup>c/</sup> .....	do.	83.2	226.0	246.0	254.1	436.0	522.6	581.8
Mercury.....	thou. flasks	76.5	140.0	152.8	155.9	245.1	288.2	317.6
Manganese ore <sup>d/</sup> .....	thou. short tons	2,866.1	7,970.3	8,307.6	8,529.1	13,992.3	15,183.9	18,150.6
Nickel.....	do.	172.1	300.2	327.6	337.1	550.2	651.7	721.0
Molybdenum.....	do.	48.6	114.8	125.3	128.9	210.6	249.5	276.1
Domestic consumption Dom. cons. plus tungsten in steel	Mil. lb.	24.1	50.0	50.0	50.0	100.0	100.0	100.0
Exports.....	do.	10.4	22.2	24.4	25.2	42.7	51.1	56.8
Tungsten <sup>e/</sup> .....	thou. lb.	4.7	11.1	12.3	12.8	22.4	27.0	30.1
Vanadium.....	thou. short tons	580.3	1,350.4	1,482.5	1,528.9	2,532.0	3,016.0	3,346.3
Diatomite.....	do.	1,685.7	4,106.4	4,561.6	4,721.3	9,338.5	11,221.8	12,508.8
Sand, gravel, and crushed stone.....	Mil. short tons							

a/ Iron content. b/ Gross weight. c/ Includes secondary, but excludes exports. d/ Not less than 35 percent manganese. e/ Other than used in steel production.

Source: (5)

Table 8.--Export Demand for Selected U.S. Metals and Minerals, 1948-65 and Projected 1980 and 2000

Commodity	Unit	1965	1980			2000		
			Low	Medium	High	Low	Medium	High
Iron and steel.....	Mil. long tons	3.1	3.7	3.8	3.9	4.2	4.5	5.4
Iron ore.....	do.	7.1		10.0 <sup>a/</sup>			20.0 <sup>a/</sup>	
Aluminum <sup>b/</sup> .....	Thous. short tons	341.0	820	905	1,059	1,598	1,914	2,130
Copper <sup>c/</sup> .....	do.	50.7 <sup>d/</sup>	*	*	*	*	*	*
Lead.....	do.	11.5	*	*	*	*	*	*
Zinc.....	do.	19.3	*	*	*	*	*	*
Magnesium.....	do.	17.8		50 <sup>e/</sup>			100 <sup>e/</sup>	
Mercury.....	Thous. flasks	7.5 <sup>f/</sup>	*	*	*	*	*	*
Manganese ore.....	Mil. short tons	e/	*	*	*	*	*	*
Nickel.....	Thous. short tons	20.9 <sup>g/</sup>	*	*	*	*	*	*
Molybdenum <sup>h/</sup> .....	Mil. pounds	24.9	63.7	69.4	71.6	117.5	139.4	154.3
Tungsten.....	do.	*	*	*	*	*	*	*
Vanadium.....	Short tons	*	*	*	*	*	*	*
Diatomite.....	Thous. short tons	114	270.1	296.5	305.8	506.4	603.2	669.3
Sand and gravel.....	Mil. short tons	*	*	*	*	*	*	*

\* = Less than 1 percent.

a/ Gross weight.

b/ Includes aluminum pigs, bars, scrap, and shapes and forms.

c/ U.S. expected to be net importer of all forms of copper.

d/ Net exports of copper scrap. U.S. is net importer of other forms of copper.

e/ Exports expected to grow, but at decreasing rate.

f/ Exports unusually high in 1964 (2,575) and 1966 (7,543). Returned to normal (357) in 1966.

g/ Includes scrap, alloys, mill shapes. Exports are almost wholly secondary and reexports, and they vary considerably. No projection attempted because it was considered not significant.

h/ Export demand may not actually be met if supplies become inadequate.

Source: (3).



discovered and the holder of the claim has had the claim surveyed, spent a minimum of \$500 on improvements and complied with other minimal legal requirements. When patent is issued, the owner pays \$5.00 per acre for a lode claim or \$2.50 per acre for a placer claim, and receives title to the land.

Public domain lands withdrawn from mining and the provisions of the mining laws total 111.6 million acres. Of this total, 87.2 million acres have been withdrawn from all forms of appropriation and 24.4 million specifically from mining. The purpose of withdrawals is shown in Table 9. More than two-thirds of the withdrawals aimed specifically at mining are accounted for by withdrawals of oil shale and other mineral lands (36 percent), and for the protection of the outdoor recreation environment in wilderness and primitive areas on national forests (36 percent). Withdrawals by state are shown in Table 10. The Western States and Alaska contain 98 percent of all withdrawn public domain.

The number of mineral patent applications received by the Bureau of Land Management since 1950 is shown graphically in Figure 1. Roughly half of the applications since 1960 have been recommended for patent upon validation of the necessary legal requirements and proof that the claim was not located on land withdrawn from the mining laws.

Records of mineral production of the so-called locatable minerals from lands claimed or patented under the mining laws are not maintained. A survey of mineral producers in the United States conducted for the Public Land Law Review Commission by the University of Arizona indicates that at least half of the mineral lands in production today were acquired under the mining laws (8). However, no records are available to show what percent of the public lands that have been patented under the mining laws actually are or have been used for mineral production. If the record of actual production on public land leased for mineral production is at all indicative of the record of production from patented lands, the percentage is probably quite small.

Of the metals and minerals considered in this chapter, only five have been produced from Federally owned public domain and acquired land--phosphate, potash, sodium and sulfur, copper, lead, and sand and gravel.<sup>2/</sup> Copper and

<sup>2/</sup>The procedures by which Federal land is offered by competitive and noncompetitive leases under the Mineral Leasing Act of 1920 and the Outer Continental Shelf Act of 1953 have been discussed in the previous chapter.

Table 9.--Public Domain Land Withdrawn from All Forms of Appropriation and Specifically Withdrawn from Appropriation by Mining, by Purpose of Withdrawal, 1967

(Million acres)

Purpose of Withdrawal	Type of Restriction		
	Total	General <sup>a/</sup>	Specific <sup>b/</sup>
Administrative sites	0.2	c/	0.2
National forest reservations	...	...	...
Classification	2.2	1.5	0.7
Protective withdrawals	0.2	0.2	c/
Prohibit mining entry and leasing <sup>d/</sup>	8.7	...	8.7
Grazing	c/	...	c/
Water and power projects	23.2	23.2	...
Other water uses	1.6	0.1	1.5
Aid of Wildlife	26.3	25.4	0.9
Outdoor recreation	10.1	1.5	8.7
Townsites and other spatial uses	2.6	1.5	1.1
State selection	0.3	...	0.3
National parks and monuments	16.9	15.0	1.9
Science, education and research	2.1	1.8	0.3
Military purposes	17.2	17.2	c/
Total	111.6	87.2	24.4

<sup>a/</sup>Restrictions against all forms of appropriation, including mining.

<sup>b/</sup>Withdrawals specifically for purpose of preventing mining not included in a "general" withdrawal.

<sup>c/</sup>Indicates less than 50,000 acres.

<sup>d/</sup>Includes mainly oil shale lands in Colorado, Utah, and Wyoming.

Source: (9).



Table 10.--Public Domain Land Withdrawn from All Forms of  
Appropriation and Specifically Withdrawn from  
Mining, by State, 1967  
(Million acres)

State	Type of Restriction		
	Total	General <sup>a/</sup>	Specific <sup>b/</sup>
Alaska	40.9	38.9	2.0
Western States	(68.6)	(47.8)	(21.0)
Arizona	11.0	9.3	1.7
California	13.1	10.0	3.0
Colorado	3.3	1.7	1.6
Idaho	2.6	1.9	0.7
Montana	4.5	3.0	1.5
Nevada	7.6	7.5	0.1
New Mexico	4.7	3.6	1.1
Oregon	3.5	1.5	2.0
Utah	10.0	4.9	5.2
Washington	1.6	0.8	0.8
Wyoming	6.9	3.6	3.2
Eastern States	2.1	0.5	1.4
Total	111.6	87.2	24.4

<sup>a/</sup> Restrictions against all forms of appropriation, including mining.

<sup>b/</sup> Withdrawals specifically for purposes of preventing mining not included in a "general" withdrawal.

Source: (10).



NUMBER OF  
CASES REVIEWED  
400

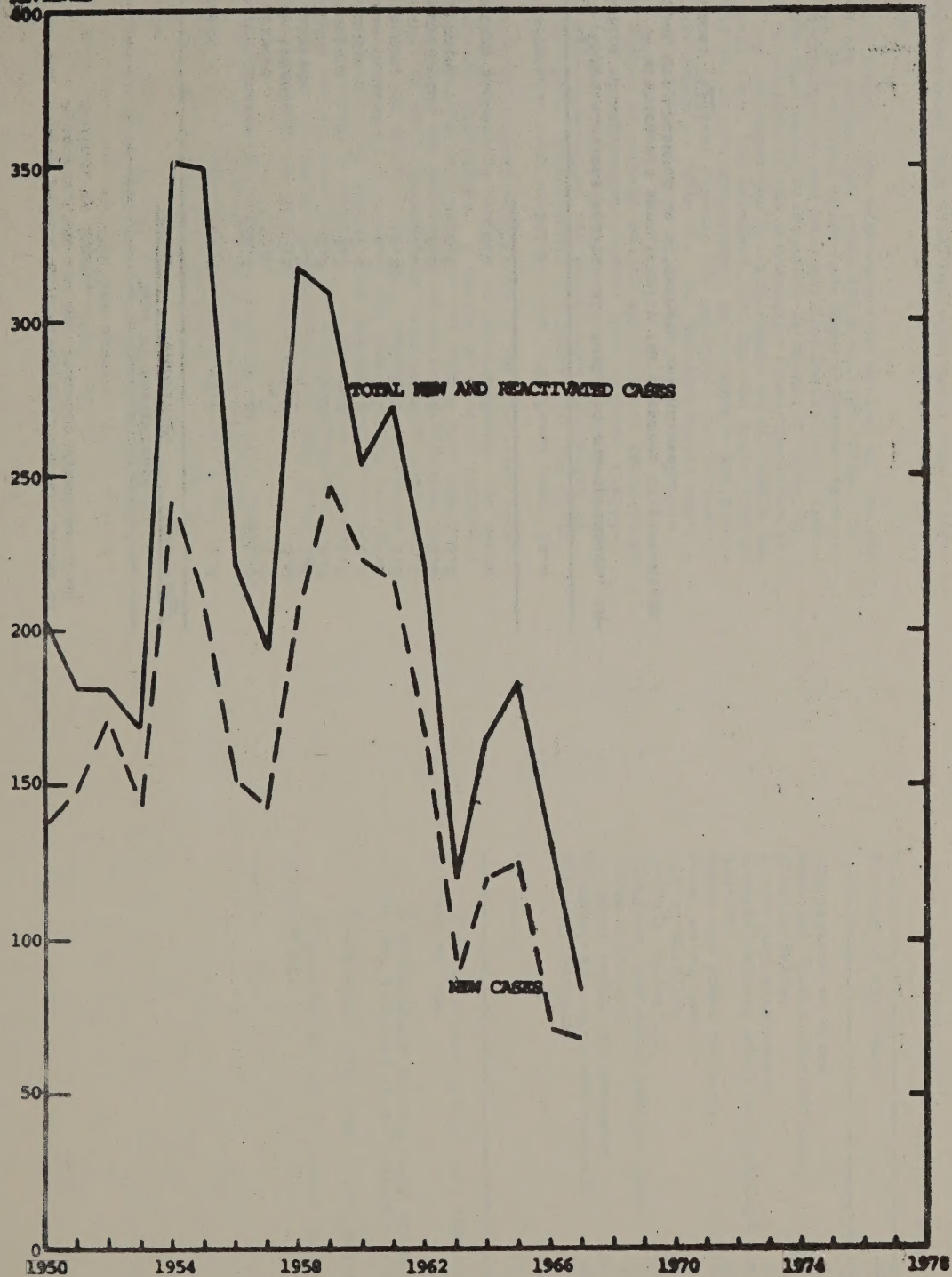


Fig. 1 - Mineral Patent Applications, Cases for Review

Source: (8).



lead are apparently the only metalliferous minerals that have been produced by leaseholders of acquired lands under the Acquired Lands Leasing Act.

Production of phosphate rock, potash (potassium salts) and sodium salts on leased public domain lands and of sulfur from the outer continental shelf are given in Table 11, along with the receipts obtained from rents, royalties and bonuses. Production of phosphate rock, copper and lead, and sand and gravel on leased acquired lands is shown in Table 12.

All of the phosphate rock production from public domain lands comes from leaseholders in Idaho and Montana. Approximately 6 percent of the total United States output of phosphate came from these lands in 1967, up from about 2 percent in 1947. Phosphate production from acquired lands in Florida is a negligible factor in the national supply. Potassium produced principally from the public domain in New Mexico plus a small amount of production from leased lands in California has accounted for between 75 and 95 percent of national domestic production since 1960.<sup>3/</sup> Sulfur production from outer continental shelf leases began in 1960, and by 1966 it accounted for 17 percent of total United States output (6). Sodium production from leased public domain lands accounted for about 8 percent of national production in 1947 but has since declined to less than half of one percent.

Lead and copper have been produced by leaseholders of acquired Federal land in Missouri since 1961 and 1966, respectively. Production of both of these metals has consistently represented less than half of one percent of national production. Sand and gravel production from acquired lands has been erratic, rising from 4,000 tons in 1950 to 450,000 tons in 1956, dropping to 3,000 tons in 1964, and up to an all-time high of nearly 5 million tons in 1967.

Under the provisions of Public Law 359, the Mineral Disposal Act, as amended by the "Common Varieties" Act of 1955, the Federal Government conducts competitive and non-competitive contract sales of minerals and allows for the free use of minerals by Federal agencies and nonprofit organizations. In 1968, 820 sales were made producing a revenue of \$93,600. All of these sales were in the 11 Western States and were primarily for industrial materials

<sup>3/</sup>The percentage of the potassium produced on Federal lands that is marketable is not reported by the Bureau of Land Management in (1).

Table 11.--Receipts and Production from Leased Public Domain and Submerged Outer Continental Shelf Lands, Selected Minerals, 1947-1968  
(Millions of dollars and Millions of short tons)

Year	Leased Public Domain Lands <sup>a/</sup>				OCS <sup>b/</sup>			
	Phosphate Rock		Sodium Salts		Potash (Potassium Salts)		Sulfur	
	Rec. <sup>c/</sup>	Prod.	Rec. <sup>c/</sup>	Prod.	Rec. <sup>c/</sup>	Prod. <sup>d/</sup>	Rec. <sup>e/</sup>	Prod.
1947	f/	0.1	f/	0.4	0.9	4.1	...	...
1948	f/	0.2	f/	0.5	1.1	4.6	...	...
1949	f/	0.3	f/	0.5	1.2	5.0	...	...
1950	0.1	0.3	f/	0.5	1.2	4.4	...	...
1951	0.1	0.1	f/	0.7	2.1	5.4	...	...
1952	0.1	0.3	f/	0.6	1.8	5.4	...	...
1953	0.1	0.5	f/	0.6	2.5	7.9	...	...
1954	0.2	0.5	f/	0.7	2.6	7.5	0.1	...
1955	0.2	0.6	0.5	0.7	3.0	7.8	0.1	...
1956	0.3	1.1	0.1	0.9	3.1	9.4	0.1	...
1957	0.6	0.9	0.2	0.9	3.0	8.8	0.1	...
1958	0.3	1.2	0.2	0.9	4.9	10.0	f/	...
1959	0.3	1.0	0.2	1.0	3.6	10.8	f/	...
1960	0.3	1.3	0.3	1.0	4.0	13.0	f/	0.1
1961	0.3	1.3	0.6	1.0	3.1	12.9	f/	0.4
1962	0.3	1.0	0.2	1.0	4.7	12.6	f/	0.3
1963	0.6	1.0	0.2	1.0	5.1	13.6	f/	0.6
1964	1.1	1.2	0.5	1.6	5.6	14.6	f/	0.6
1965	1.2	1.4	0.6	1.5	6.2	16.3	0.2	1.1
1966	1.1	2.6	1.1	f/	7.7	17.8	0.2	1.4
1967	1.4	2.0	1.2	f/	11.0	17.3	0.2	1.3
1968	1.1	2.1	1.2	f/	8.9	14.3	N.A.	1.4

<sup>a/</sup>Includes national forest lands originating from the public domain; excludes military and naval reserves.

<sup>b/</sup>Production from the Gulf Coast OCS; receipts from all OCS lands.

<sup>c/</sup>Includes rents and royalties.

<sup>d/</sup>Total production (vs. marketable or salable production as shown in Table 2).

<sup>e/</sup>Includes bonuses of \$1,233 in 1954 and \$33,740 in 1964 and annual rents and royalties.

<sup>f/</sup>Indicates less than half the unit shown.

Source: Public domain lands data for 1947-1965 from (3); for 1966-1968 from (1). OCS, 1954-1966 from (6); 1968 from (1).



Table 12.--Production of Phosphate Rock, Copper, Lead, and Sand and Gravel on Leased Acquired Federal Lands, 1947-1968<sup>a/</sup>  
(Thousand short tons)

Year	Phosphate Rock	Copper	Lead	Sand and Gravel <sup>b/</sup>
1947	...	...	...	...
1948	...	...	...	...
1949	...	...	...	...
1950	...	...	...	4
1951	c/	...	...	5
1952	4	...	...	32
1953	3	...	...	24
1954	5	...	...	8
1955	4	...	...	98
1956	4	...	...	299
1957	4	...	...	450
1958	4	...	...	253
1959	4	...	...	265
1960	8 (5) <sup>d/</sup>	...	...	310
1961	5 (7)	...	4	197
1962	6 (7)	...	8	77
1963	4	...	3	3
1964	5 (3)	...	12	3
1965	2	...	17	24
1966	5	1	14	1,351
1967	2	1	25	4,904
1968	1	1	85	N.A.

<sup>a/</sup> All lead and copper production is from leases in Missouri; phosphate productions from leased lands in Florida.

<sup>b/</sup> Includes rock, stone and sand.

<sup>c/</sup> Less than 500 short tons.

<sup>d/</sup> Numbers in parentheses indicate data obtained from the Bureau of Land Management (1) which disagree with production recorded by Clawson (3).

Source: Phosphate rock, sand and gravel data for 1948-1964 from (3); 1965-1968 data from (1). Data for copper and lead from (1).

such as sand, gravel, stone, and rock (1). Free-use permits were issued to 323 users in 1968 for materials with an appraised value of \$1.7 million. All free-use permits were also in the Western States. By way of comparison, 1960 sales totaled \$91,200, and the appraised value of materials consumed under free-use permits was \$748,400.

#### Future Nonfuel Mineral Production from Federal Land

In the previous chapter, it was noted that it is virtually impossible to project the role of the Federal lands as a source of future fuels. The explanation given was that: (1) Federal control of production is indirect and limited to the offering of leases, (2) future production of leased Federal land will occur only if minerals can be located and then only when economic and technological conditions are such that it is more economical to obtain minerals from Federal lands than from other lands (or imports), and (3) it is impossible to project the economic and technological conditions that will permit production from Federal land because of the largely unknown nature of mineral resources on these lands.

These same conclusions must also apply to leasable and locatable nonfuel minerals. In the case of the leasables the historical record of the importance of Federal leaseholder production of potash and sulfur would seem to indicate that a substantial portion of the future production of these minerals will come from Federal lands. However, the trends indicated by the rapid growth in the relative importance of sulfur production from the Outer Continental Shelf beginning in 1960 and rising to 17 percent of national output in 1966, and the 75- to 95-percent share of national potassium production that has come from leased onshore public lands since 1960 cannot be expected to automatically continue into the future. Because of the three reasons cited above, the percentage of domestic production that will be accounted for from public lands by 1980, 2000, or any future date is not obvious, or predictable.

For the metals and other minerals locatable under the provisions of the Mining Law of 1872, there are literally no historical data on production from patented Federal lands. Nor are there estimates of potential production from lands acquirable under the mining laws.

In the past, exceptionally favorable treatment has been given to mining interests compared with other users and potential users of Federal lands. In the future, continued



and increasing pressures for the use of Western Federal land for recreation purposes, timber and water production, and the growing national concern with the quality of environment may prove to be incompatible with mineral production on some areas of Federal land. Given these pressures, public policy may dictate that more Federal land be withdrawn from mining entry. If this occurs, the potential for mineral production from leased and patented Federal land will decrease, simply because there is less area available for exploitation by mining and mineral interests.

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## CHAPTER IX

### ANALYSIS OF POLICY IMPLICATIONS OF FUTURE DEMANDS

Data presented in the previous chapters provide an inventory of the current production of the various commodities produced from public lands and estimates of the likely magnitude of public land output in the foreseeable future. The projections of likely future output presented were not predictions of what will be or must be, or statements of what should be supplied from public lands. They were derived from extrapolations of historical trends of the percentages of past production that were accounted for by public lands as applied to estimates of future production requirements from all landownership sources as modified by judgments of the impact of differing future conditions.

The projections of likely future output from public lands for individual commodities were made under the assumption that there would be no significant changes in economic factors or government policy affecting levels of output, other than those judged to be occurring from historical trends. The projections also implicitly assume that sufficient funds and personnel would be made available to Federal agencies to carry out the land management and other programs necessarily associated with the future levels of output. Whenever either of these two assumptions appeared to be of particular importance as a qualification of projected public land output or to be incompatible with the projection, this was so noted.

The item of concern in this chapter is the implication of the projected levels of output from Federal lands for public policy. The general magnitude of the entire set of projections presented in previous chapters is examined in terms of what they may imply in relation to the possible effects of alternative government policies affecting level of output for individual commodities. This aspect of government policy is distinct from policy questions regarding the production of individual commodities, questions as to

whether actual production of the projected future demands will be in the public interest, and the desirability of attainment of the projected output level for one commodity over another when future conflicts in use appear probable. Alternatives to current government policy relating to specific commodity areas are discussed in a major section of each of the commodity studies prepared for the Public Land Law Review Commission.<sup>1/</sup> Answers to policy questions concerned with what is in the public interest would require detailed knowledge of the economic impact of alternative levels of output of individual commodities upon different segments of the United States economy and a precise identification of those interests that are to be served by public land management. Both of these items are subjects of other studies being undertaken by the PLLRC and are beyond the scope of this report.

#### The Nature of Public Land Output Projections

The projections of output from public lands presented in this report are not projections of economic supply or of economic demand. In an economic sense, the term "supply" refers to a schedule of the alternative amounts of a commodity that producers are willing to sell at alternative prices at a given point of time. The term "demand" is similarly defined as a schedule of the alternative amounts of a commodity that consumers are willing to buy at alternative prices at a given point in time. Historical data used to derive the projections of likely public land output reveal only the quantity of a good or service that was provided from public lands over a given time period, usually a year. Such data do not indicate very much about the respective economic supply and demand schedules that resulted in the recorded output figure. They do not indicate what quantities would have been provided if the quantities offered by Federal agencies or demand by consumers were offered or demanded at higher or lower prices.

The long-range projections of the future output from public lands provided are, therefore, projections of likely future output rather than projections of output that will

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<sup>1/</sup> The completed commodity reports dealing with land occupancy uses, outdoor recreation, and nonfuel minerals were not available when this report was prepared. It is assumed that these reports will follow the format used in other commodity reports and will contain similar sections.



result from future economic demand and supply conditions. The only economics involved in the projections is the modification of the statistical extrapolations of past consumption or production trends based upon subjective judgments about what will happen in the future.

#### Probable Conflicts between Uses of Public Lands

The previously developed projections of commodity requirements from all lands and the likely future role of the public lands as a supplier of these commodities are summarized in Table 1. For purposes of comparison, the projections are shown as indexes of projected output with current production or use equal to an index value of 100.

For wildlife habitat, energy fuel minerals and nonfuel minerals, available data did not permit meaningful projections for the public lands as distinct from all lands. The projection indexes shown for public land production of these commodities given in Table 1 are enclosed in parentheses to indicate that they are identical to the projections of production from all lands and are not directly comparable with other items in the public land columns. The use of total requirement projections for public land output is not meant to imply that the public lands will continue to supply the same percentage share of output as they currently provide. Public lands are expected to become an increasingly important source of wildlife habitat and minerals, but the magnitude of the change in relative importance is not identifiable.

The major policy implication of the projections summarized in Table 1 is that conflicts between alternative uses of public lands will intensify. The most likely sources of major conflicts center around the production of water, outdoor recreation opportunities, timber, and minerals. Production of these commodities from public lands is expected to be from 2.0 to 4.6 times as great in 2000 as they are now. In some respects, each of these uses is or will be incompatible with other uses and will require policy decisions to establish priority of use. Attainment of the projected level of output for any one of these commodities could require some withdrawal of public land for exclusive production, as it is probably impossible to meet all of the projections under current policy and land use patterns. If these withdrawals are large, the production of other commodities at the projected levels will require sufficient funds to undertake intensification of management activities

Table 1.--Indexes of Medium Level Projections of Total Future Requirements for the Likely Output from the Federal Lands for Selected Goods and Services, 1980 and 2000 (Current index value is 100)<sup>a/</sup>

Item	Total Requirements		Output from Federal Land	
	1980	2000	1980	2000
Agricultural cropland <sup>b/</sup>	100	100	100	100
Livestock forage <sup>c/</sup>	131	183	77	55
Wildlife habitat <sup>d/</sup>	128	173	(128) <sup>j/</sup>	(173)
Outdoor recreation <sup>e/</sup>	160	241	242	465
Timber <sup>f/</sup>	145	178	165	204
Water <sup>g/</sup>	132	162	130	240
Energy fuel minerals <sup>h/</sup>	152	242	(152)	(242)
Nonfuel minerals <sup>i/</sup>	177	336	(177)	(336)

a/The year used to represent "current" production varies by commodity from 1965 to 1968.

b/Cropland requirements in the 11 Western States.

c/Animal unit months of forage required by domestic livestock in 11 Western States, assuming that national forage requirements will increase at a compound rate of 1.8 percent per year from 1966 to 2000.

d/Expected increases in hunting license sale in the 11 Western States. The indexes for 1980 and 2000 fishing license sales in the West are 167 and 325, respectively.

e/Participation in major outdoor recreation activities. For Federal lands, recreation visits to national parks, other Park Service areas, the national forests and wildlife refuges.

f/Timber products production. Indexes of production on Federal land assume that these lands will supply 26 percent of national output.

g/Index for "total requirements" are water consumption in the eight water resource regions in the West; for "Federal land," data for water withdrawals in the same water resource regions.

h/BTU's of power to be produced from oil, gas and coal.

i/Tons of phosphate rock, potash and sulphur needed for domestic consumption or export.

j/Index numbers in parentheses are identical to those given in the "total requirements" column. Federal lands are expected to be an increasingly important source of wildlife habitat and minerals, but sufficient data are not available to provide indicators of how total future demands will be allocated between Federal and all other lands.



over and above those required just to meet the projected output levels.

The projected 465-percent increase in outdoor recreation by 2000 refers to recreational visits to national parks, other Park Service areas, and the national forests and wildlife refuges. Recreational use of other Federal lands was not specifically considered, but should increase proportionately. This projection is nearly twice the projected level of nationwide participation in outdoor recreation activities, but substantially lower than the projected increase of 880 percent in outdoor recreation on state lands. To provide for the projected increase in use in a manner that will not reduce the recreational attractiveness of these Federal areas because of visitor congestion, a large portion of the projected increase in visits must be accommodated on areas not currently used for recreation purposes. If the projected 465-percent increase in outdoor recreation on public land is to be realized, large investments in new facilities will be required and conflicts with other land uses will have to be resolved. Resolution of the conflicts may mean less water, timber, forage or other resources than could be produced under specific management for a particular use. But, it may also mean that less recreation will be supplied that requires extensive land areas, particularly the dedication of additional land to primitive and wilderness areas which require the exclusion of other land uses.

The year 2000 projections for timber indicate that the public lands will become increasingly important as a source of timber. Probable demands on public lands will require a 204-percent increase in public land timber production, as compared with a 178-percent increase for all ownership sources. The projected increase for public lands is a physically attainable level of production if no further reservations of commercial timber land for recreation and other purposes occur. Adequate funds and personnel will also have to be available to permit the intensification of timber management that would be required to provide this level of output. Should further withdrawals of commercial forest land or other timber-cutting restrictions be made to meet requirements for recreation, watershed or other purposes, the need for intensive management on remaining lands will increase further, as will Federal agency budget requirements.

As shown by Table 1, water withdrawals in the West's eight water resource regions are expected to increase by 1.3 times by 1980 and by 2.4 times by 2000. Since Federal lands in the West supply close to 62 percent of the water yielded from all lands, the pressure on these lands for water

production will increase proportionately. Although the long-term water yield in the West is expected to exceed withdrawals by 1.5 times in the year 2000, local shortages will continue. The local shortages may require more intensive watershed management on Federal lands. In some areas, land uses that damage or destroy watershed values may have to be curtailed or prohibited if, again, the projected level of output from Federal lands is to be met.

The role of the Federal lands as a future supply source of energy and nonfuel minerals is uncertain. Increasing national requirements would indicate that in 2000, 2.4 times as much fuel mineral production and 3.6 times as much nonfuel mineral production will occur on public lands than occurs now, assuming no change in the relative importance of public lands as a supply source. Under the existing laws affecting the exploitation of minerals on public land, mineral interests are afforded favorable treatment compared with other users and potential users of Federal lands. A continuation of the policies prescribed by these laws would indicate that if the proper economic conditions exist for mineral production from public lands, needed production would be forthcoming. However, the magnitude of the projections of uses of Federal land for recreational opportunities, timber and water production, and the growing national concern with the quality of environment may prove to be incompatible with mineral production on some areas of public land. Given these pressures, public policy may dictate that more Federal land be withdrawn from mineral exploitation now possible through lease or mining entry. If this occurs, the potential for mineral production from leased and patented Federal land could decrease, simply because there will be less public land available for exploitation by mining and mineral interests.

Major new conflicts are not expected to arise from the future use of the public lands for intensive agriculture and livestock forage production. Future use of public land for agriculture is expected to remain constant, and the relative importance of public lands as a source of livestock forage will decline. Similarly, future demand for use of the Federal lands as wildlife habitat is not expected to have particularly significant nationwide effects on other uses of public lands. With adequate funding of wildlife programs, wildlife habitat maintenance can be complementary with the production of other goods and services.

In addition to the potential conflicts noted above, the future disposal or use of public lands for occupancy uses



could have a significant impact upon the realization of the commodity projections. Occupancy uses encompass such uses of the spatial values of public lands as rights-of-way, governmental, residential, commercial and similar uses. Although these uses were not specifically covered in this study, they are expected to increase, and are likely to have higher social, economic or political value than many other future uses of public lands. Future occupancy uses of Federal lands will, therefore, place additional constraints upon attainment of the projected levels of output from Federal lands for the seven commodity areas considered.

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History of Public Land Law Development. Written by Professors Paul Wallace Gates of Cornell University and Robert W. Swenson of the University of Utah. 1968. \$8.25

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Clearinghouse prices for these reports are based upon the number of volumes into which each report is divided, indicated for each report in the following listing. Price: \$3.00 per volume for paper printouts unless specified otherwise. \$0.65 per volume for microfiche.

Federal Legislative Jurisdiction. Prepared by the Land and Natural Resources Division, United States Department of Justice. Revised September 1969. One volume. Order number P B 185 920.

Study of Withdrawals and Reservations of Public Domain Lands. Prepared by Charles F. Wheatley, Jr. Revised September, 1969. Order numbers: P B 187 002, P B 187 003, P B 187 004.

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